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Current and temperature measurements are presented from instruments deployed during May of 1976 in the western Indian Ocean, between 50°E and 57°E and between 1°S and 5°N. The experiment was part of the INDEX program.

Seven mooring sites were occupied. Fourteen current meters and five temperature/pressure recorders were on WHOI moorings at 4 of the sites. Two current meters and eleven temperature/pressure recorders were on MIT moorings at 3 sites. Most of resulting data records are of eight months duration. A current profiler, the White Horse, was also used, and 41 profiles were taken over a six-week period.

Basic data from the current meters are presented in statistical tables and graphically as scatter plots, progressive vector plots, spectral plots and time series plots. Filtered time series are shown in composite displays.

Basic White Horse data are presented as east and north current component profiles, position plots and perspective vector plots.

Selected CTD data are displayed as plots of potential temperature and salinity versus pressure, and as T-S diagrams. Data from four XBT sections are displayed graphically.

WHOI-80-41

A COMPILATION OF MOORED CURRENT METER DATA, WHITE HORSE PROFILES AND ASSOCIATED OCEANOGRAPHIC OBSERVATIONS, VOLUME XXIV (INDIAN OCEAN ARRAY, 1976)

by

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and James R. Luyten

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts 02543

October 1980

TECHNICAL REPORT

Prepared for the Ocean Science and Technology Division of the Office of Naval Research under Contract N00014-76-C-0197; NR 083-400 and for the National Science Foundation under Grants ATM76-02196, ATM78-21491, and DES72-01384.

Approved for Distribution ____________________
Valentine Worthington, Chairman
Department of Physical Oceanography

ABSTRACT

Current and temperature measurements are presented from instruments deployed during May of 1976 in the western Indian Ocean, between 50°E and 57°E and between 1°S and 5°N. The experiment was part of the INDEX program.

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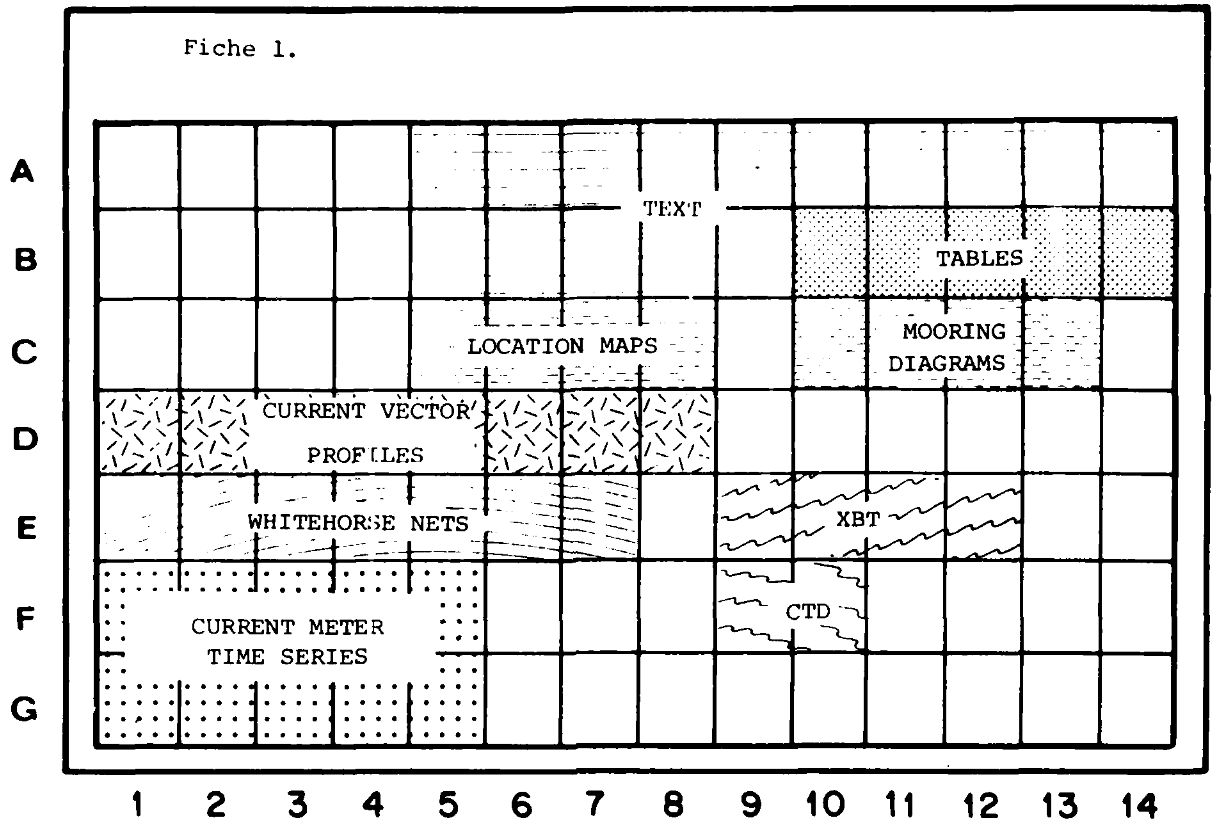

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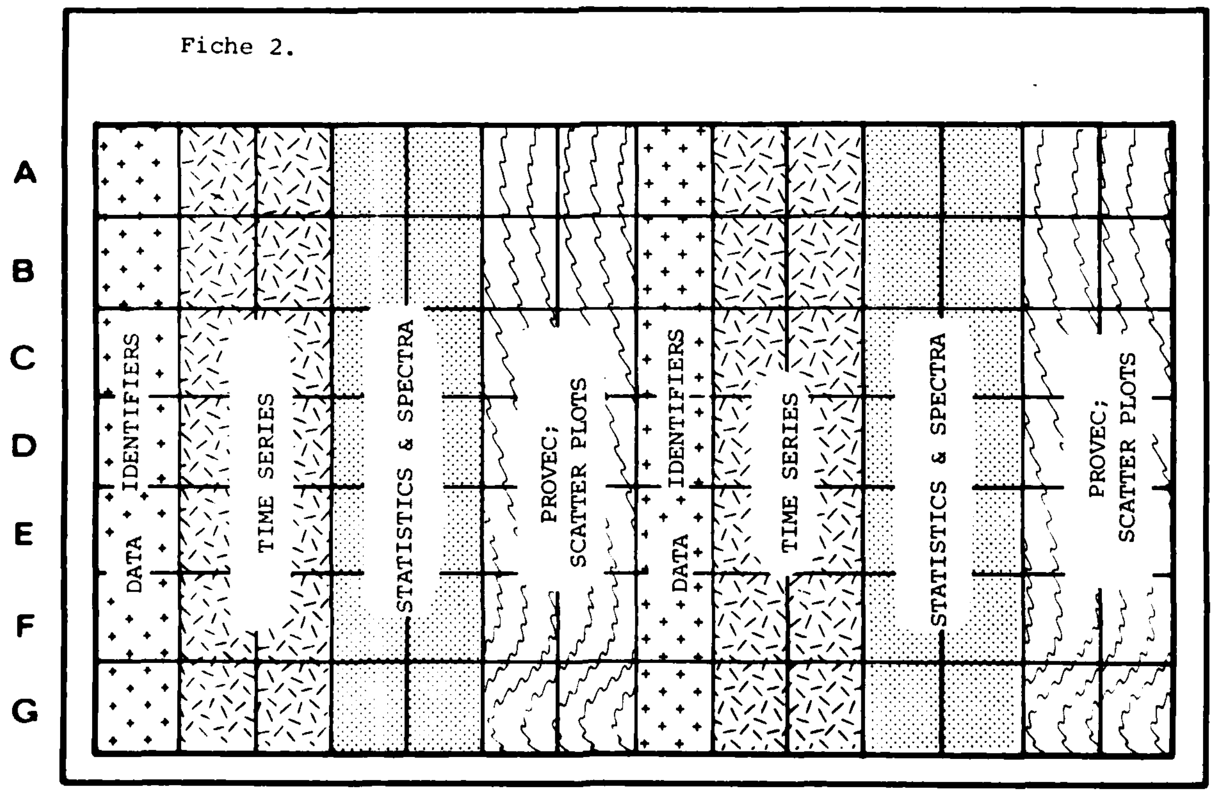

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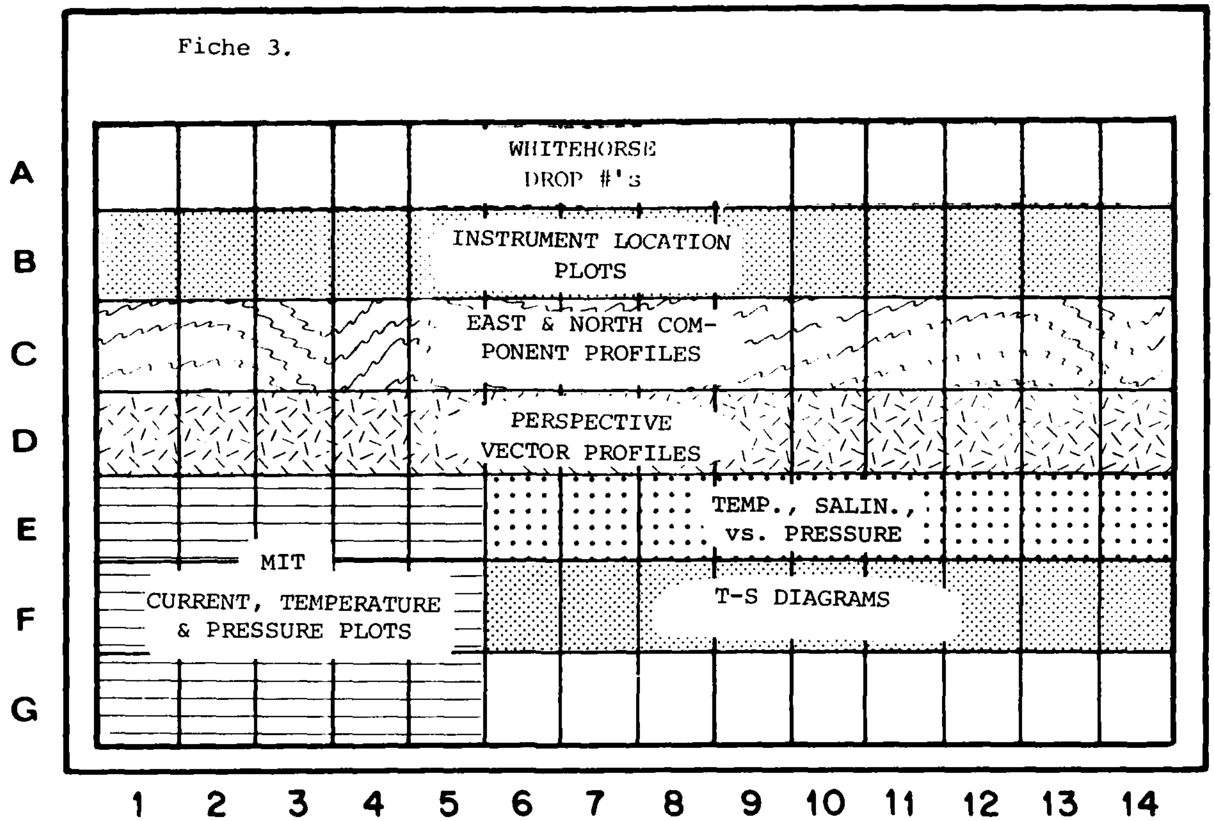

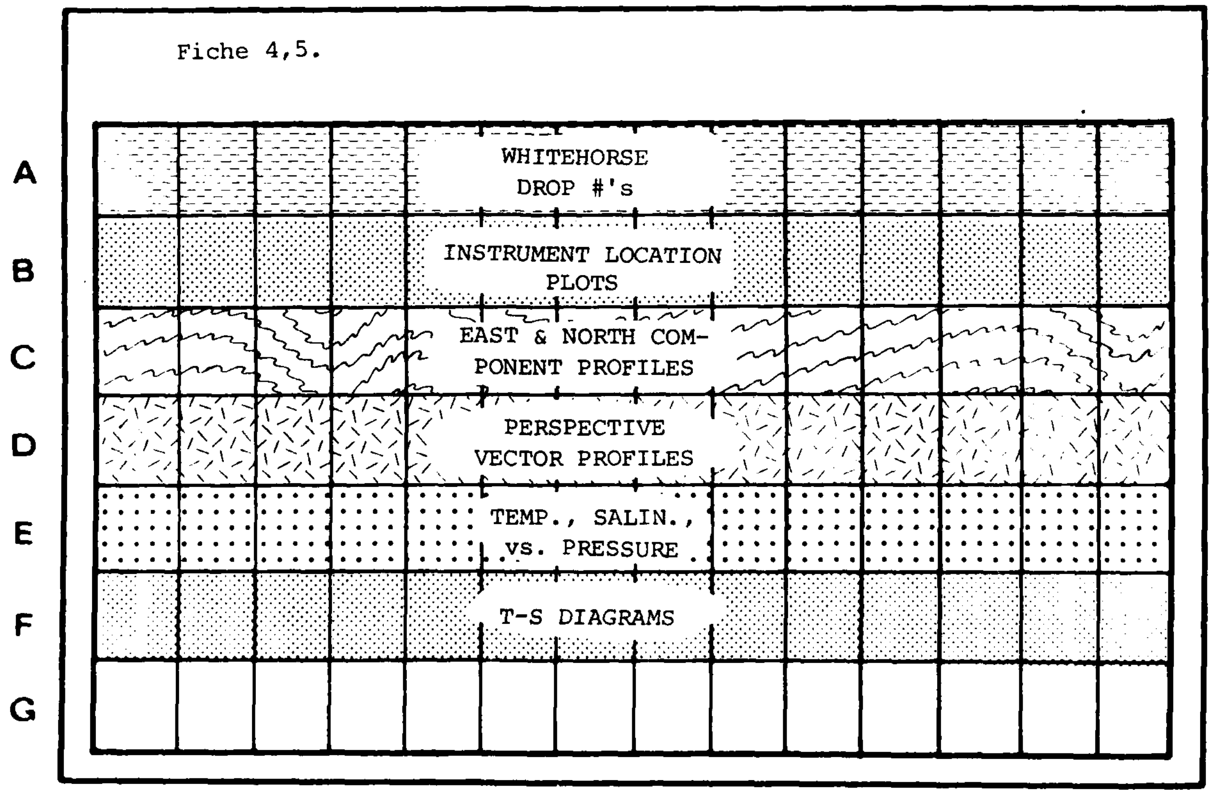

ACKNOWLEDGMENTS

Many people should share the credit for the good quality of data obtained from the instruments set during this experiment; the people in the Buoy Group instrument shop, those who worked on mooring hardware and design, and those who contributed to the development of the White Horse system. The officers and crew of the R/V ATLANTIS II deserve special mention for their willing assistance with mooring deployment and recovery and for their efforts to help develop techniques for White Horse handling. The principal investigator for this experiment was Dr. James R. Luyten. Gordon Volkmann prepared the CTD and XBT plots, and Gerald Needell was of great assistance with the processing and editing of the White Horse data. The T/P data and MIT current meter data are courtesy of Drs. C. Wunsch and C. C. Eriksen, respectively, at MIT.

The experiment was supported jointly by the Ocean Science and Technology Division of the Office of Naval Research (Contract number N00014-76-C-0197, NR 083-400) and the National Science Foundation (Grant numbers ATM76-02196 and ATM78-21491). The analysis of the T/P data was supported by the National Science Foundation (Grant number DES72-01384).

PREFACE

This volume is the twenty-fourth in a series of Data Reports presenting moored current meter and associated data collected by the WHOI Buoy Group.

Volumes I through XXIII present data obtained during the years 1963-1978, arranged either by year or experiment (see notes).

A data directory and bibliography for the years 1963-1978 has been published, as WHOI Technical Report 79-88.

Volume XXIV presents data from the INDEX Experiment, 1976.

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XIV	77-41	Tarbell, S., R. Payne and R. Walden	1976 mooring 592 Saint Croix
XV	77-56	Tarbell, S. and A. W. Whitlatch	1971 measurements
XVI	78-5	Tarbell, S. and A. Spencer	1971-1975 MODE Site
XVII	78-49	Tarbell, S., A. Spencer and R. E. Payne	1975-1977 POLYMODE Array II
XVIII	79-65	Tarbell, S., M. G. Briscoe and R. A. Weller	1978 JASIN
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PRESENTATION

The printed portion of the report contains introductory text and information about the instruments and data processing procedures. Tables and figures give summaries of the location of the instruments. Data are shown graphically in numerous composite displays.

These pages are also reproduced on Sheet 1 of the microfiche. Sheet 2 contains displays of the basic current meter data, including spectral plots, tables of statistics, time series plots, progressive vector diagrams and scatter plots.

The White Horse data are shown on Sheets 3, 4 and 5 in the top four rows. Displays include velocity component profiles, perspective vector plots and horizontal position plots. CTD plots are shown in the next two rows and plots of the data from the T/Ps and current meters from MIT are shown in the bottom left corner of Sheet 3.

A detailed layout of the data on the microfiche sheets is shown on pages iii and iv.

INTRODUCTION

Seven moorings, with a total of 16 current meters and 14 T/P recorders, were set in May, 1976, and recovered in December, 1976. Forty-one velocity and CTD profiles were taken with the White Horse between May 13th and June 19th. See Figures 1, 2 and 3 and Tables 1 and 3 for details of instrument locations, and Figure 4 and Tables 2 and 4 for times and data quality. In Tables 1 and 2, note that records from moorings 594 and 597 are continuous in time at the same location. Mooring 594 was accidentally released after 3 weeks. It was reset as mooring 597. The data were collected as a component of the INDEX-76 experiment, a pilot investigation of the western equatorial Indian Ocean. These pilot observations were used to define an oceanographic component (INDEX-79) to the First GARP Global Experiment (FGGE), recently completed.

Scientific analyses of data from this experiment have appeared in the following references: Luyten and Swallow (1976), Swallow and Luyten (1976), Luyten (1980), Eriksen (1980) and Luyten (2 papers submitted).

INSTRUMENTATION

Current Meters

The current meters described in this report were Vector Averaging Current Meters (VACMs), built by AMF SeaLink Systems (now EG and G SeaLink Systems), or Model 850 current meters built by Geodyne, now a part of Egerton, Germeshausen and Grier (EG and G).

Each time a pair of rotor magnets passes the sensing diode, the VACM samples compass and vane information and computes a measure of east and north water current components. These components are summed through the entire recording interval, usually 15 minutes, thus giving a true vector average. One complete rotor revolution initiates 8 compute cycles. Temperature is derived from a voltage-to-frequency converter (v/f), whose output frequency is related to the thermistor resistance at its input. The v/f output pulses are summed over the entire recording interval, thus averaging temperature. The thermistors are routinely calibrated before and after deployment and the temperatures are accurate to ±.01°C (Payne et al., 1976). All variables are recorded on a cassette tape at the end of each recording interval.

The Model 850 current meter stores burst sampled data on magnetic tape cartridges. The instrument collects and stores 23 or 24 data cycles sampled at 5.27 second intervals. It then turns off for the remainder of the recording interval (usually 15 or 30 minutes). Model 850's which are modified to include temperature measurements accumulate the count from the temperature circuit from one 5.19 second period and store it at the beginning of each data burst.

Time was measured using a quartz crystal oscillator with a manufacturer's specified accuracy of ±1 second per day. All stated times are in UTC (Universal Coordinated Time). The instrument clock times were synchronized with UTC before mooring launch. After recovery, differences in the two times were noted.

The Aanderaa current meters deployed by MIT also use a Savonius rotor to sense water motions. At the end of a recording interval, the total number of rotor turns for that interval, instantaneous compass, vane values and thermistor output are recorded. A quartz crystal oscillator is used for timing.

Temperature/Pressure Recorder

An instrument to record temperature, pressure and time (T/P) was developed in the Draper Laboratory at MIT for MODE-1 and has been used extensively since 1973. The instrument stores a sample every 15 seconds and records the sum of 64 successive data samples every 16 minutes on a magnetic tape cassette (64 x 15 = 960 seconds = 16 minutes).

Temperatures have a resolution of .001°C (Wunsch and Dahlen, 1974). The absolute accuracy is not specified.

The pressure sensor is a strain gauge with a manufacturer-specified accuracy of .03 per cent of full scale (Wunsch and Dahlen, 1974). These sensors are recalibrated for each instrument deployment.

XBT

450-meter XBT probes were dropped along the four transits to and from the working area. Of the four sections made, section 2 extended from Mombasa to 57°E, the others only to 53°E. Surface currents were measured from ship's drift. Surface temperature and salinity were measured hourly along the transits. The plots show the vertical temperature sections from the XBTs, with surface current vectors, surface temperature and salinity along the tracks.

White Horse

The White Horse is a freely-falling, acoustically self-navigating dropsonde used to determine vertical profiles of horizontal ocean currents. The instrument records internally the round-trip travel time for an acoustic pulse between the instrument and up to 4 bottom moored acoustic transponders. In this experiment, three bottom beacons were routinely used when available: for each survey, and for at least the first drop at each net, after which the third beacon was usually recovered for use at another net.

The sampling interval is 20 seconds, so that the three dimensional position is determined every 20 seconds. Successive positions are differenced to obtain an average velocity over the 20 second (~20 meter) vertical interval. A second instrument, the Black Horse, is similar to the White Horse. Its electronics are identical, but its exterior configuration is different, which results in a different fall rate. It suffered electronic and mechanical difficulties during this experiment. For details on the design, evaluation and performance, see Luyten et al. (1980).

CTD

A Neil Brown Instrument Systems CTD (Brown, 1975) was mounted on both the White Horse and the Black Horse. Vertical profiles of temperature and salinity were obtained from the White Horse in most cases; the Black Horse CTD malfunctioned. The sampling rate for the CTD is 1Hz, so that at a fall rate of approximately 1 m/sec, a vertical resolution of 1 meter is obtained. The in-situ calibration of the CTD was accomplished by fitting the deep sigma-theta curves to that obtained from a hydrographic station, occupied while the White Horse profile was being made. Table 4 indicates at which drop sites a CTD profile yielded good data. Plots of temperature and salinity versus depth and T-S diagrams are displayed on microfiche for these CTDs and a sample is shown in Figure 11.

MOORINGS

Details of mooring configuration are shown in Tables 5-8. The items on each mooring are listed together with depths in meters and data names. Due to the accidental release of Mooring 594, it is listed in combination with replacement Mooring 597. Both depths are listed, if different, and both data names are listed.

The anchors, unless otherwise stated, are 3000 pound wet weight cylinders.

The item "17" balls and chain" refers to glass flotation spheres of 17" diameter with hard hats, each one bolted to 3/8" chain at 1 meter intervals.

Figure 2 shows mooring locations and Tables 1 and 2 give summaries of the instruments, their depths and the quality of the data. Figure 3 shows the depths of the instruments on the moorings and water depths. Note that the depths for the MIT triplet are measured up from the bottom.

See Heinmiller (1976) for a more complete description of WHOI moorings.

DATA PROCESSING

Current Meters

The data from the instrument tapes were transcribed to 9-track magnetic tapes, converted to scientific units, edited to remove launch and retrieval transients and bad points, and linearly interpolated across missing or erroneous data cycles.

WHOI data are identified by a mooring number, a sequential instrument position number (e.g., 5953 is the third instrument down on mooring 595), a letter to indicate the data version (e.g., 5953B is the second editing of 5953), and a number to indicate the time sampling interval for that data record (e.g., 5953B1800 is the half-hour (1800 seconds) averaged version).

Low passed versions of data series were formed by passing the data through a Gaussian filter with a 24 hour half-width, and then subsampling the filtered series once a day. The composite plots shown for each WHOI mooring and the plots of the data from MIT use these filtered data series.

MIT current meter records are named with a prefix DO or DL, and only low passed data are shown in this report, on microfiche.

Temperature/Pressure Recorders

Preliminary cassette reading and data processing were done at MIT. The basic time series received by WHOI were truncated to remove launch and retrieval transients, but no detailed editing was done. Basic spectral plots, time series and statistics are shown for the T/Ps on the WHOI moorings, and the low passed temperature data are shown on the composite temperature plots for each mooring. Low passed data is shown on fiche for the T/Ps on the MIT moorings.

White Horse

Processing of the White Horse data consists of:

1. Transferring raw data from the instrument cassette to 9-track magnetic tape.
2. Decoding to obtain travel times, conductivity, temperature and pressure at 20 second time intervals.
3. Converting travel times and pressure to positions relative to the beacons. Editing occurs before and during this step.
4. Converting travel time to slant range using a vertical ray approximation and the sound velocity profile obtained from the CTD.
5. Converting changes in position to velocity components at depth intervals of 25 meters, by linear interpolation. Further editing may be done at this stage.

A survey of the beacon positions is run at each drop site (net). The coordinates of the acoustic transponder net are estimated using a bootstrap technique whereby the transponders are interrogated from various positions at a known depth near the ocean surface. Typically the range is determined from 13 different locations at the surface. The net parameters are estimated using a least squares technique developed by Hunt et al. (1974). After step 2 the survey tape data are processed to obtain beacon locations, shown in Table 3 and these data are used for step 3.

Diagrams of the nets and surveys are shown in Figure 7. Summaries of the time, location and data quality at each drop are given in Tables 3 and 4. East and north components of velocity and velocity 'stick' vectors are shown on microfiche for each drop of the White Horse. The depth is computed from the pressure reading of the instrument and the velocities are averaged over 25 meter intervals, the uppermost point shown being an average of surface points. Conductivity is not shown and temperature and salinity are displayed on CTD plots.

Data records are identified by net and drop number, e.g., record 603 is the third drop at the Net 6 location.

There is a problem noted in Table 4, the 4 millisecond problem. Interference occurs when returning signals from two transponders arrive within 4 milliseconds of each other: only the first is recorded.

PROGRAMS

Time Series

Current meter variables versus time are presented graphically. Plots from WHOI temperature/pressure recorders are based on the 1920 or 1800-second sampling interval data series, subsampled every 4 hours. Only low passed data are shown for the MIT T/Ps. The composite plots (Figures 8-10) are based on daily averaged time series.

Statistics

Statistics for each variable measured by the current meters and T/Ps are presented on microfiche, Sheet 2, in columns 4, 5, 11 and 12. Mean, standard error, variance, kurtosis and extrema are given for all the variables; east and north covariance, correlation and other statistics are given for the vectors. For reference, note that a Gaussian random variable would have a kurtosis of three and a skewness of zero.

See Volume XVII (POLYMODE Array II) of this series for a more detailed discussion of these parameters.

Progressive Vector and Scatter Plots

Based on a daily averaged time series, the current vectors are placed tail-to-head so as to show the path that a perfect particle in a perfectly homogeneous flow would have travelled. Flow regimes and low frequency behavior show up well on this type of plot. The plot begins with an asterisk and the first day of each month is marked with a plus sign and annotated.

Every second point from the series is plotted in a scatter plot, in which east and north components are plotted as points on a polar diagram. The line drawn through the points is the principal axis. It has slope theta (θ) (where theta is given by $\tan(2\theta) = (2\overline{uv}) / (\overline{u^2} - \overline{v^2})$) and it passes through the point $(\overline{u},\overline{v})$.

White Horse Plots

The east and north component profiles are plotted with one point every 25 meters, for both the down and up traces. No further smoothing is done, but surface points are averaged together to give one value at zero meters.

The 'perspective' vector plot is an isometric plot, so the length of the vector is its true length: it is not foreshortened for a perspective effect. For the vectors in Figure 6 and for the individual drop plots shown on microfiche, the vector at each depth is an average of the up and down values. These data are then passed through a triangular averaging filter over three depth points. For the plots in Figure 5, an average vector for the net is computed at each depth, and the resulting vector profile is passed through a triangular averaging filter over five depth points.

The position plot shows the position of the instrument in an x-y plane since it falls through the water and then rises again. A point is plotted approximately every 20 seconds and the distances are measured from Beacon 1, the origin beacon of the net. An extra plot is shown for 1103 as position values were markedly different in the two configurations used to make a final composite profile. In the case of 1101, where a composite was also formed, the differences were much smaller. In both cases, noise in Beacon 1 signals was the problem. The plot for 501 shows a change of scale, to include the top 500m of the up trace, which was used to form a combined profile.

Vector Stick Plots

The 24-hour averaged current components are plotted as individual vectors along a time scale. Unless otherwise indicated, the vector orientation is such that north is upwards on the page.

Spectra

The horizontal kinetic energy (HKE) and temperature are displayed as spectra. The HKE spectrum is half of the sum of the spectra of the east and north components. It has the advantage of not being tied to a particular coordinate system.

The HKE and temperature have units of $(cm^2/sec^2))/cph$ and $(^\circ C)^2/cph$ respectively. The spectra are all one-sided, i.e., the area under the spectrum is equal to the variance of the original record. The plots are log-log rather than 'variance preserving', i.e., the contributions of various frequency bands to the total variance are not in proportion to the displayed areas.

The spectra are calculated based on data sequences of 2560 points (a 'piece'), with the exception of the 900 second basic series which are split into three pieces. Frequency band averaging is across five frequencies, giving a lowest frequency of 1/21.3 cycles per day and a highest frequency of 2.4 cycles per day. No data-windowing or prewhitening is done.

TIMSAN, the WHOI program (Hunt, 1977) used to produce the spectra, additionally averages the spectra in increasing groups at the higher frequencies to prevent having to plot thousands of points. This procedure gives few degrees of freedom (d.o.f) at the lowest frequencies, many at the highest frequencies. For the spectra calculated from one piece with five frequencies averaged (most of the spectra), there are 10 d.o.f. in the 40 lowest frequencies, and 120 d.o.f. in the highest frequency. The 95 per cent confidence limits corresponding to these two extremes are (3.08, .49) and (1.31, .79).

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TABLE 1

SUMMARY OF MOORINGS

Record No.	Depth (m)	Date Set	Date Retr.	Location	Bottom Depth (m)
		A II, Cruise 93			
		Leg VIII	Leg XV		
WHOI					
5931	203	May 13	2 Jan.	0° 3.1'N	5082
5932(T/P)	501	1976	1977	50° 28.3'E	
5933	1500				
5934	3545				
5941	201	May 15	11 June	0° 0.6'N	5074
5942(T/P)	501	1976	1976	52° 59.6'E	
5943	1500		(Leg IX)		
5944	2508				
5945	3544				
5951	202	May 18	4 Jan.	1° 30' N	5117
5952(T/P)	500	1976	1977	52° 59.4'E	
5953	1500				
5954	3542				
5955(T/P)	4549				
5961(T/P)	252	May 19	31 Dec.	0° 0.1'S	4711
5962	551	1976	1976	56° 59.9'E	
5963	1550				
5964	3595				
5971	201	June 12	1 Jan.	0° 0.9'N	5072
5972(T/P)	501	1976	1977	52° 58.9'E	
5973	1500	(Leg IX)			
5974	2508				
5975	3544				
MIT					
D0190	4437	May 17	3 Jan.	0° 45'N	5053
DL191(T/P)	4438	1976	1977	53° 0.1'E	
DL192 "	4741				
DL193 "	4950				
DL194 "	5037				
D0200	4442	"	"	0° 45.1'N	5091
DL203(T/P)	4930			52° 59'E	
DL204 "	5030				
DL211(T/P)	4819	"	"	0° 46'N	5057
DL212 "	4926			52° 59.6'E	

TABLE 2

DATA RETURN AND QUALITY (moorings)

Record No.	Data Dates (1976)	Comments
Current Meters		
5931	May 14 – Dec. 2	Rotor came off bearings Dec. 3
5933	May 14 – Jan. 1/77	
5934	May 14 – July 15	Rotor problem after July 15
5941	May 16 – June 10	
5943	May 16 – May 30	Tape advancement problem Instrument switched off
5944	May 16 – June 10	
5945	May 16 – June 10	
5951	May 19 – Jan. 3/77	Compass out of bearing on recovery Vane sticky due to barnacle growth No direction data
5953	May 18 – Jan. 3/77	
5954	May 18 – Oct. 2	No data written on tape in October
5955	Nov. 2 – Jan. 3/77	
5962	May 20 – Dec. 30	Unusually low speeds around Dec. 18
5963	May 20 – Dec. 30	No temperature data
5964	May 20 – Dec. 30	Temperature data looks unusual, possibly due to time problem Temperature data bad after Sept. 22
5971	June 13 – Dec. 31	
5973	– – – –	No data (see 5943)
5974	June 13 – Dec. 31	Temp. questionable after Dec. 18 Time base off 52 minutes
5975	June 13 – Dec. 31	
D0190	May 18 – June 16	
D0200	May 18 – Sept. 8	
Temperature/Pressure recorders		
5942	May 17 – May 31	Gappy record. No data shown
5955	May 18 – Jan. 3/77	
5961	May 20 – Dec. 31	
DL191	May 19 – Jan. 1/77	
DL192	" "	No temperature data
DL193	" "	
DL194	" "	
DL203	June 8 – "	Extensive editing, temp., press.
DL204	May 19 – "	
DL211	" "	Temp. data questionable towards end
DL212	" "	Press. " " "

No data for T/P records 5932, 5952, 5972

TABLE 3

WHITE HORSE DROP SUMMARY

Drop Series	Location (Beacon 1 approx.)	Date of Survey 1976	Net Coordinates beac 1: x,y,z beac 2: x,y,z beac 3: x,y,z	Orientation of Net °E of N
500	0° N 50°30'E	May 13	0, 0,5049 5291, 0,5046 1551,3950,5052	9
600	0° N 53° E	May 15	0, 0,5049 4369, 0,5043 1323,3228,5049	0
	0° N 53° E	June 15	0, 0,5049 3620, 0,5043	0
700	0° 45'N 53° E	May 29	0, 0,5054 2137, 0,5053 1154,1715,5057	0
800	1° 30'N 53° E	May 30	0, 0,5091 2192, 0,5085 1129,1834,5091	-5
900	3° N 53° E	May 31	0, 0,5099 3547, 0,5101 1745,2161,5101	7
1000	5° N 53° E	June 1	0, 0,5083 3792, 0,5083 2457,2187,5085	5
1100	0° 45'S 53° E	June 5	0, 0,4994 3880, 0,4991 2677,3439,4993	0

TABLE 4

WHITE HORSE DATA QUALITY

Drop No.	Date and		Time	Code	Beacon	Notes
501	May	14	0820	DSX	23	Top 450m of up profile combined with rest of down profile Signal lost below 4765m Beacon 1 unusable due to distance
502	May	28	1035		23	
503	May	28	1706		23	
504	June	18	1010	BDS	23	CTD flooded at 2464m down
601	May	16	0900	Z	23	Beacon 1 noisy or no signal
602	May	29	1238	*	12	North comp. noisy, upper 500m up
603	June	4	1854		12	No data
604	June	5	0018	*S	12	
605	June	6	0635	*	12	
606	June	11	0540	*D	12	Beacon 2 released from bottom with dropsonde
....	new net, due to beacon replacement					
607	June	12	2112	*	12	
608	June	15	1820	*	12	40-second sampling interval interpolated to 20 sec.
609	June	15	1933	B	12	609..heavy interpolation, less on up
610	June	16	1855	B	12	Heavy interpolation on up, above 2490m
611	June	17	1216	B	12	
701	May	17	1321		A	Instrument close to baseline
702	May	30	0815	*	23	Beacon 1 noisy
703	June	4	0655	*	A	Instrument close to baseline
704	June	6	1659	*	A	Instrument close to baseline
705	June	10	2032	*4	A	Down start at 2775m, (4) Up noisy, but O.K.
706	June	13	0637	*D4	A	No down profile above 150m Up not usable (4)
707	June	15	0803	*	A	
708	June	17	0317	BD	12	Heavy interpolation above 1600m Pressure case flooded at 3200m up No signal from bea on 3

Code	
*	Good CTD data, plot shown
B	Black Horse instrument used
D	Only 'down' profile available
S	Profile shallower than 4900m
X	Beacon 1 retrieved after drop
Z	Beacon 3 retrieved after drop
4	4ms problem, see text

Beacon Configuration	
A	All 3 beacons used for position calculations.
12	Beacons 1,2 and pressure....
23	" 2,3 " "

TABLE 4 (cont.)

WHITE HORSE DATA QUALITY

Drop No.	Date and Time			Code	Beacon	Notes
801	May	18	0254		A	
802	May	30	2346	*Z	A	
803	June	3	1855	*	12	
804	June	7	0349	*D	12	Up not usable, multiple problems No down profile above 350m
805	June	10	0753	*	12	Noisy data upper 200m
806	June	13	1517	*	12	No down profile above 200m
807	June	14	2343	*D4	12	5 point smoothing done on noisy pressure data. Heavy interpolation around 750m down (4) Up not usable (4)
901	June	1	0106	*Z	A	No up profile above 300m (rain!)
902	June	3	0444	*	12	
903	June	7	1818	*D4	12	No down profile above 100m Up not usable (4)
904	June	9	1821	*	12	
905	June	14	0411	*	12	
1001	June	2	0643	*Z	A	Heavy interpolation 300-450m up
1002	June	8	1436	*	12	No up profile above 475m
1003	June	9	0125	B	12	
1101	June	5	2202	*	AC	Below 3000m, profiles formed from 2,3 beacon case
1102	June	12	0440	*	A	
1103	June	16	0547	B	AC	950-3100m, profiles formed from 2,3 beacon case

Code

- * good CTD data, plot shown
- B Black Horse instrument used
- D Only 'down' profile available
- S Profile shallower than 4900m
- Z Beacon 3 retrieved after drop
- 4 4ms problem, see text

Beacon Configuration

- A All 3 beacons used for position calculations
- 12 Beacons 1,2 and pressure ....
- C Profile derived from indicated combination of configurations

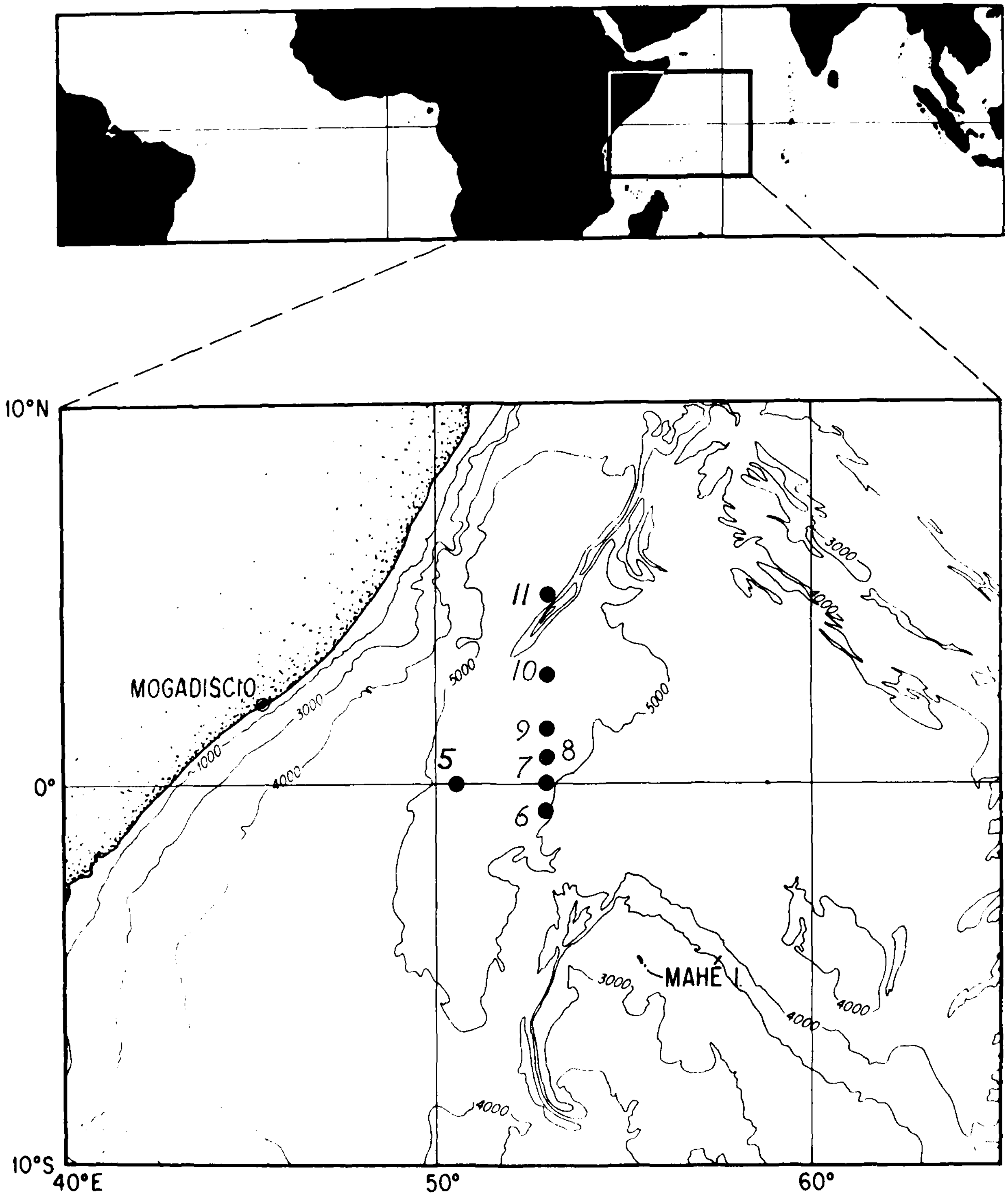


FIGURE 1

Location of Experiment
(black circles show Whitehorse drop sites)

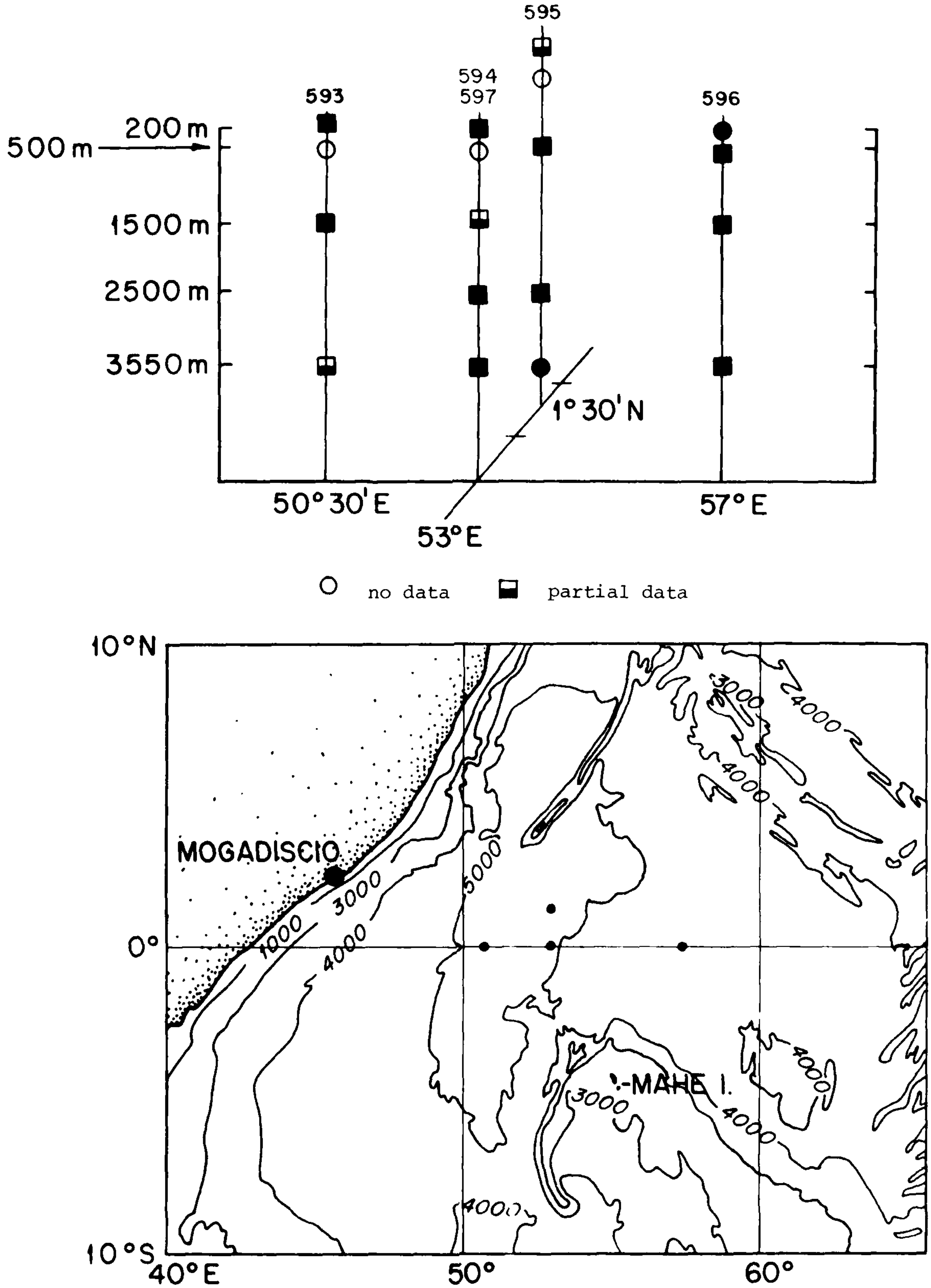
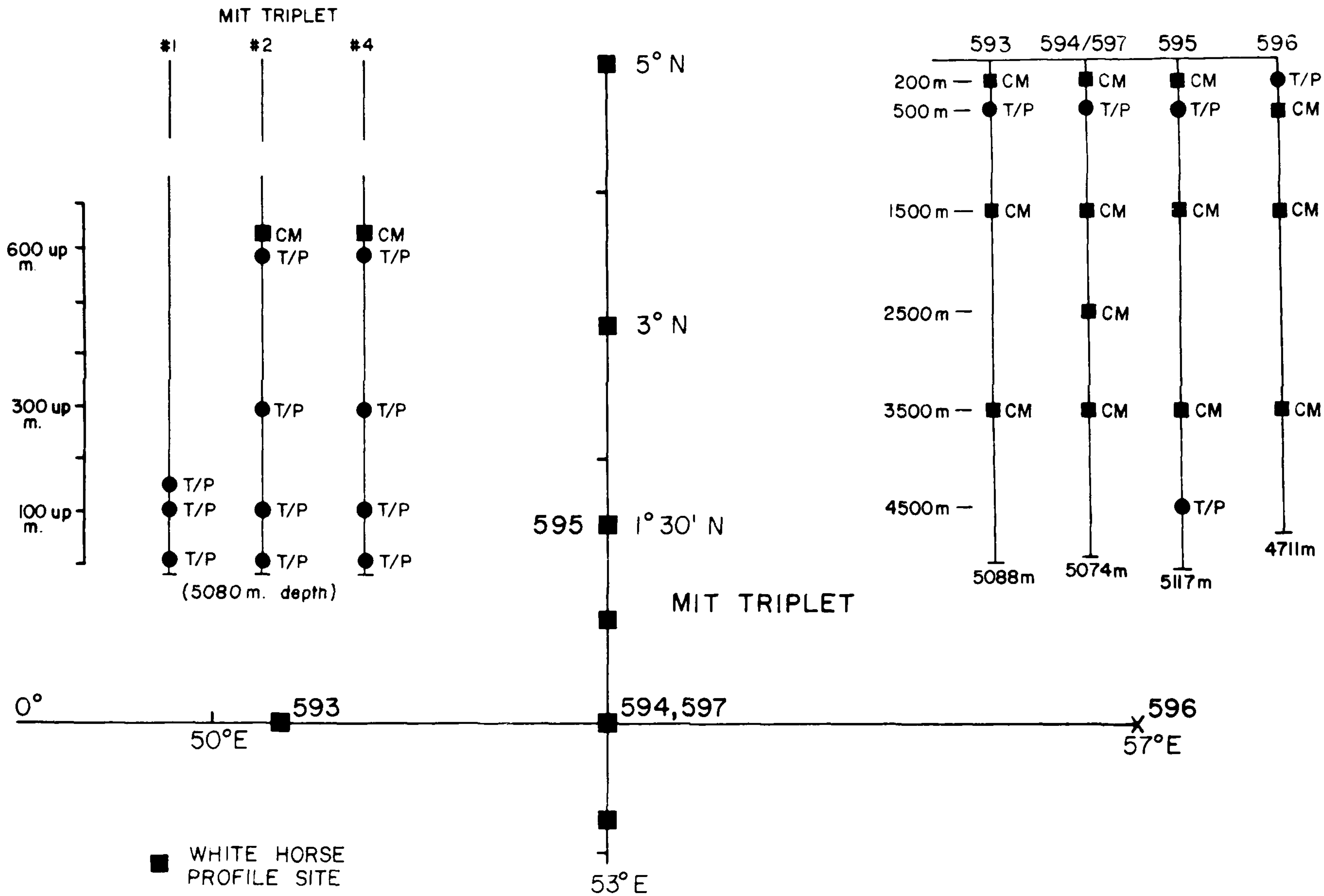


FIGURE 2
Location of Moorings

FIGURE 3

Diagram of Experiment Site and Mooring Configurations



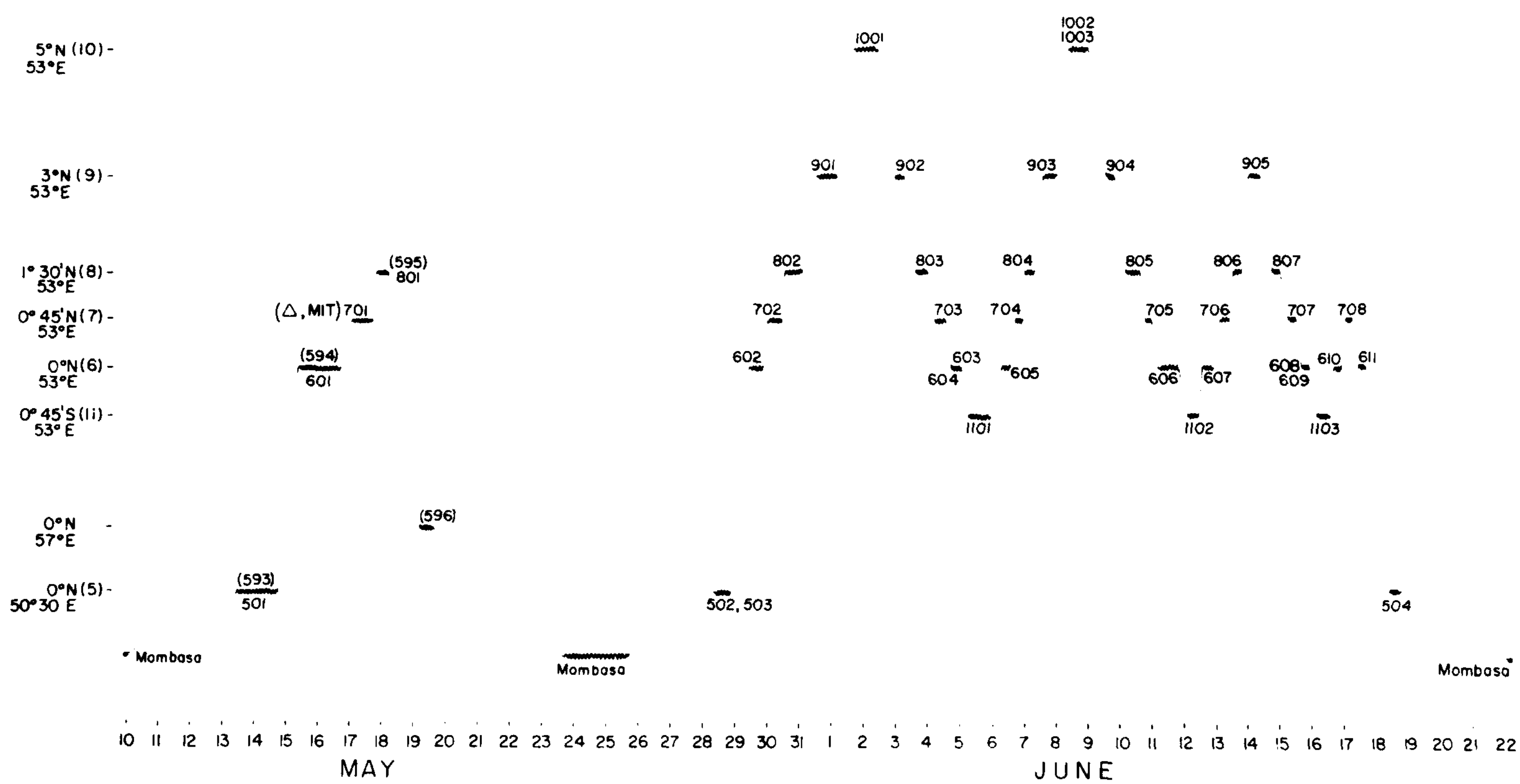


FIGURE 4

Mooring Deployment (e.g., (596)) and Whitehorse drops (e.g., 806) as a function of time

AVERAGE PROFILE, NET 5

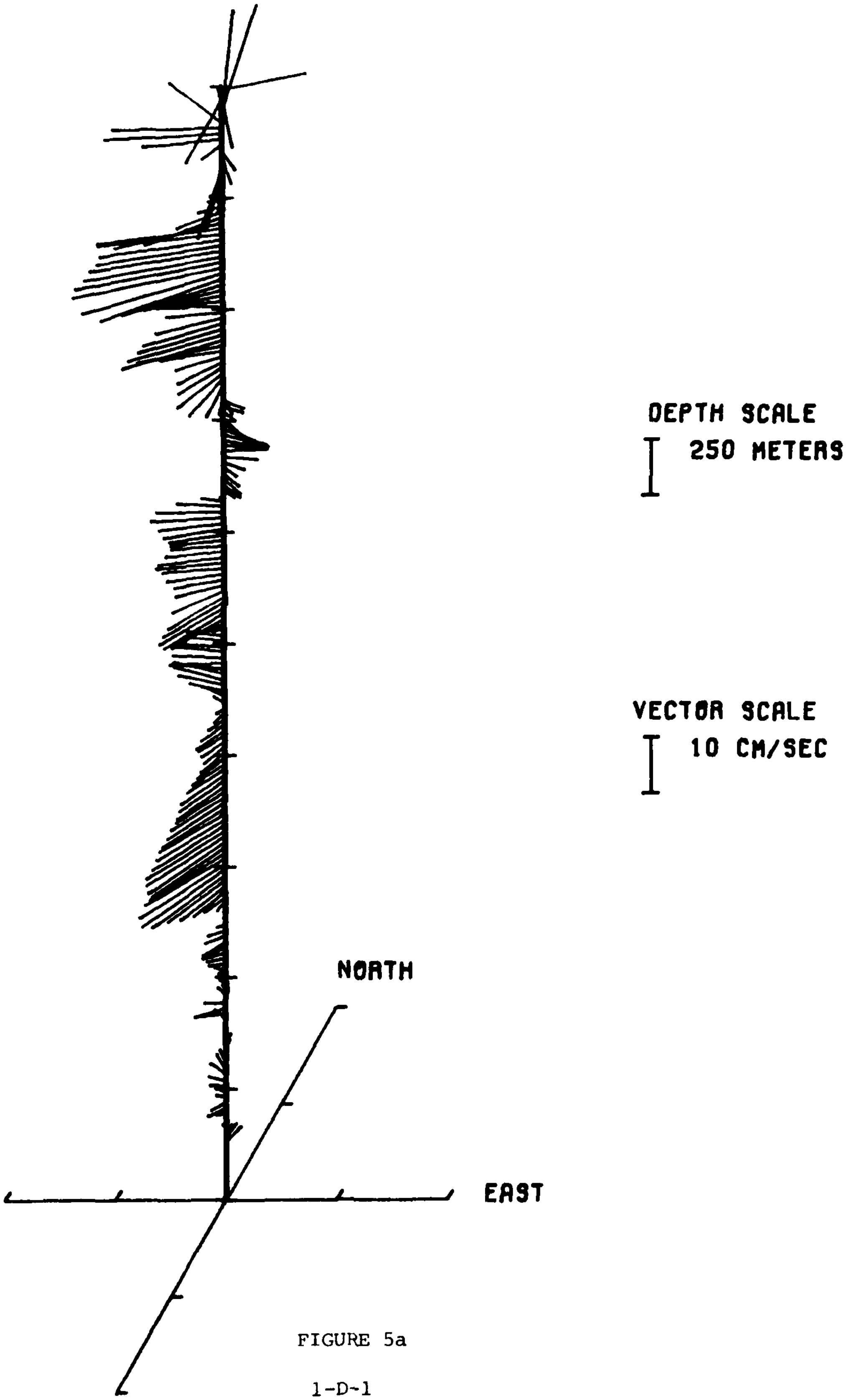


FIGURE 5a

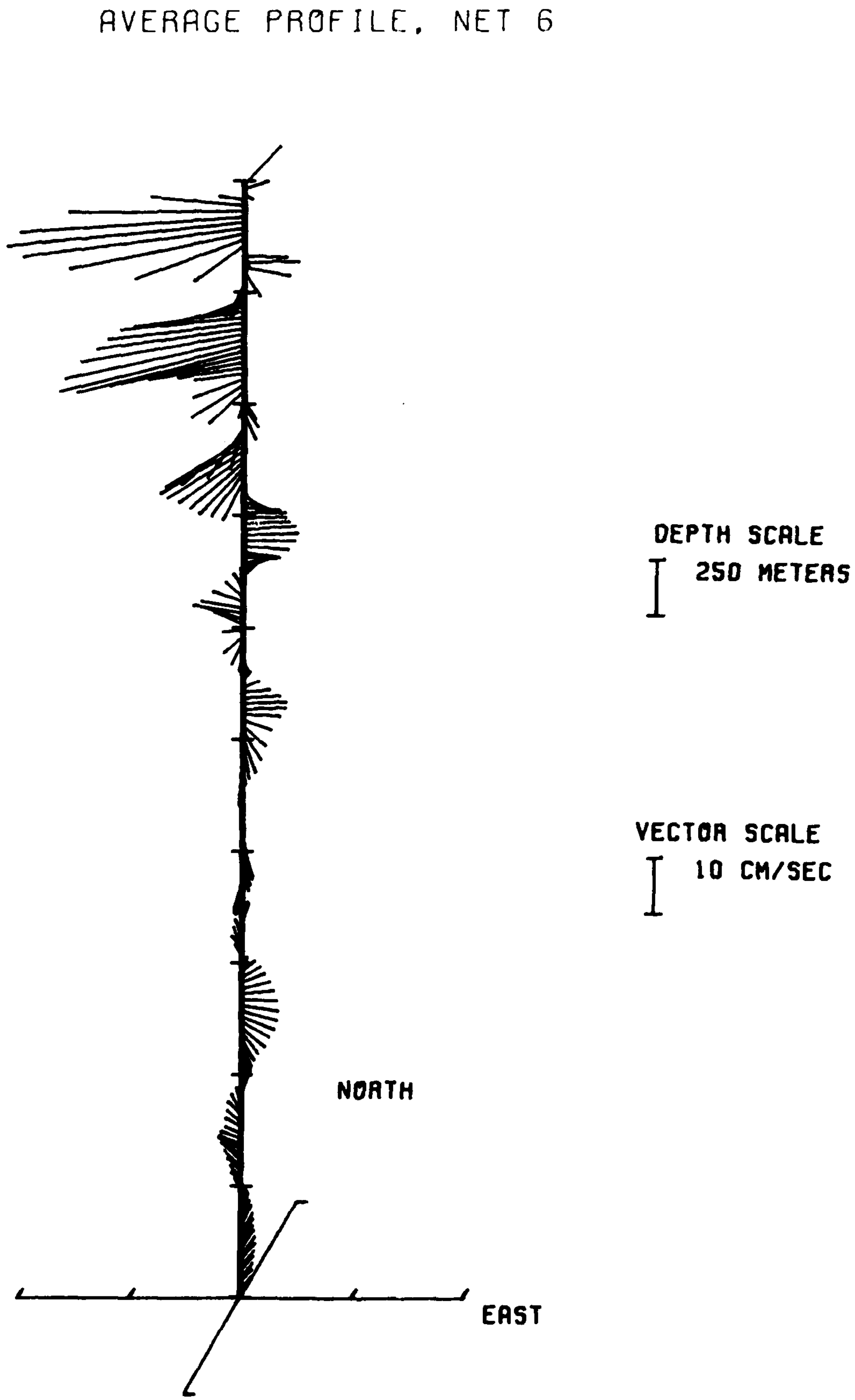

AVERAGE PROFILE, NET 6
DEPTH SCALE
250 METERS
VECTOR SCALE
10 CM/SEC
NORTH
EAST

FIGURE 5b

AVERAGE PROFILE, NET 7

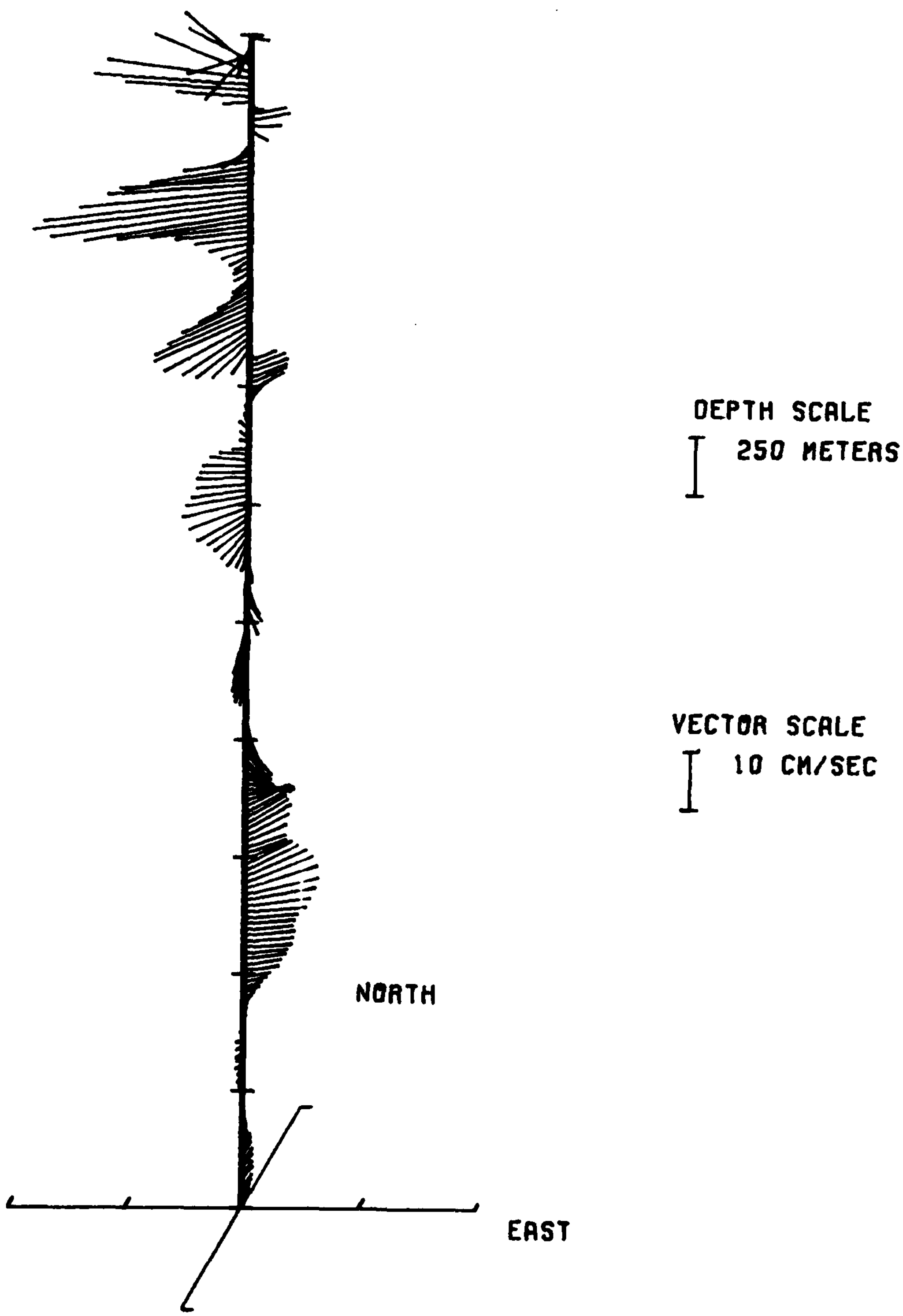


FIGURE 5c

AVERAGE PROFILE, NET 8

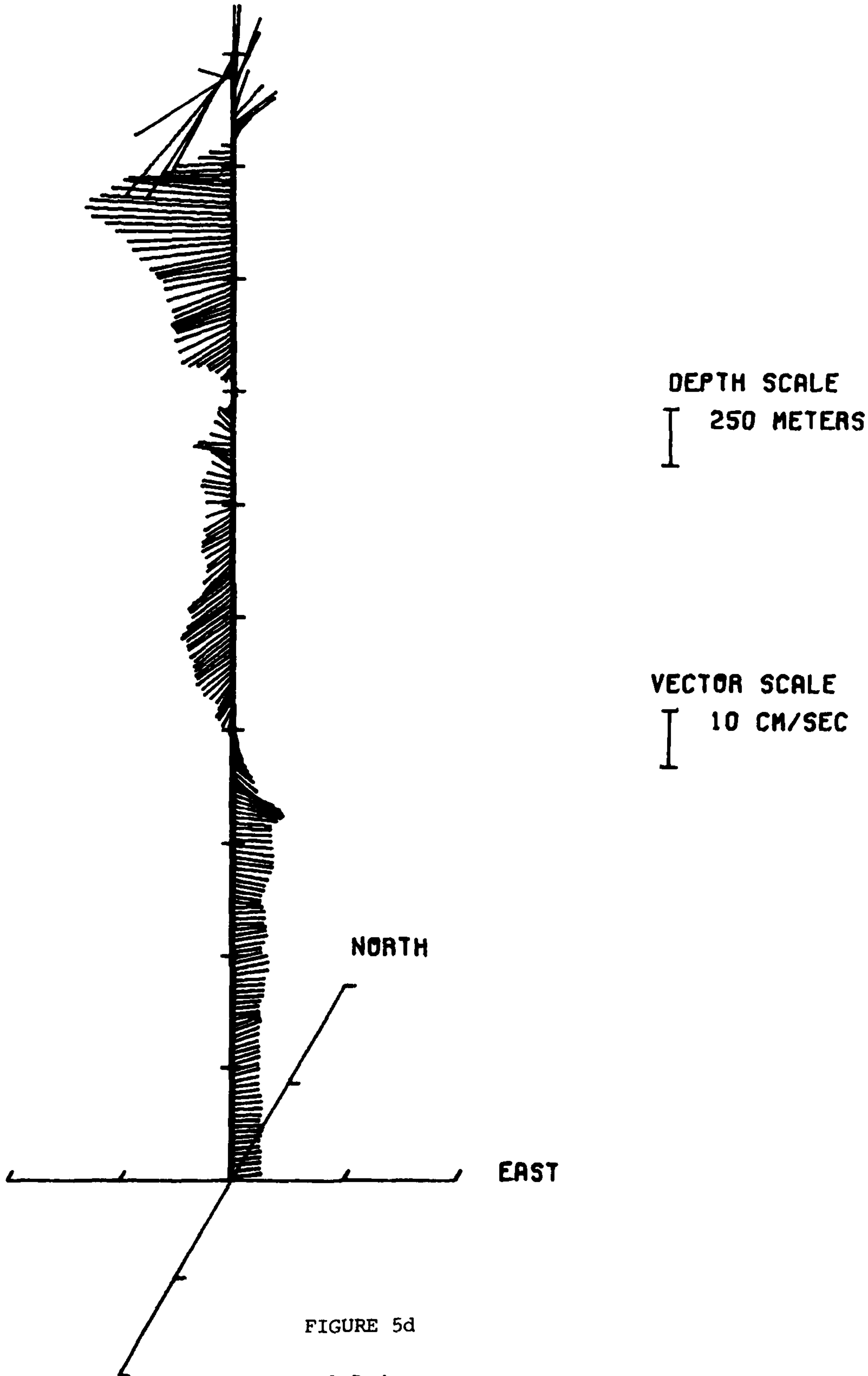


FIGURE 5d

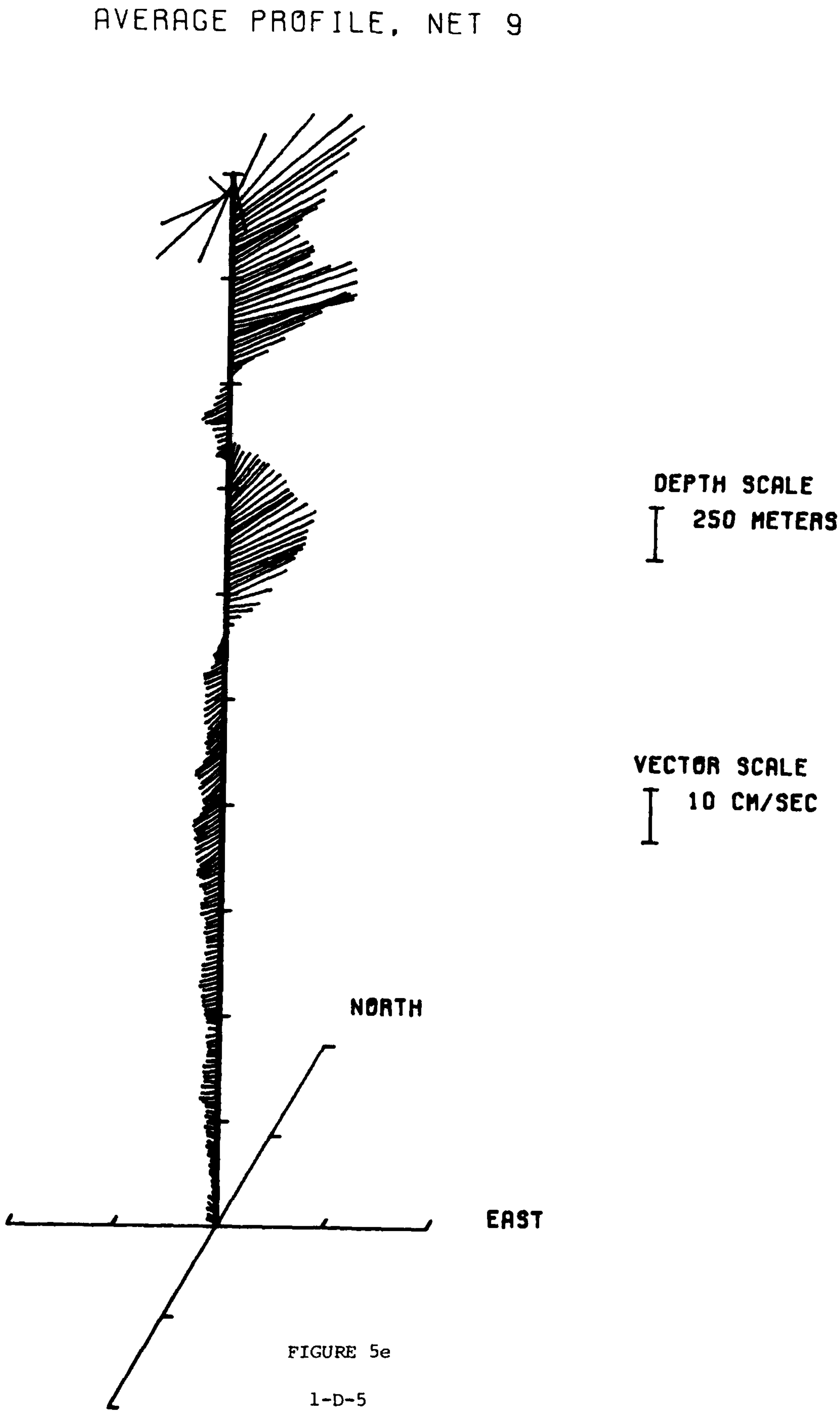

AVERAGE PROFILE, NET 9
DEPTH SCALE
250 METERS
VECTOR SCALE
10 CM/SEC
NORTH
EAST

FIGURE 5e

AVERAGE PROFILE, NET 10

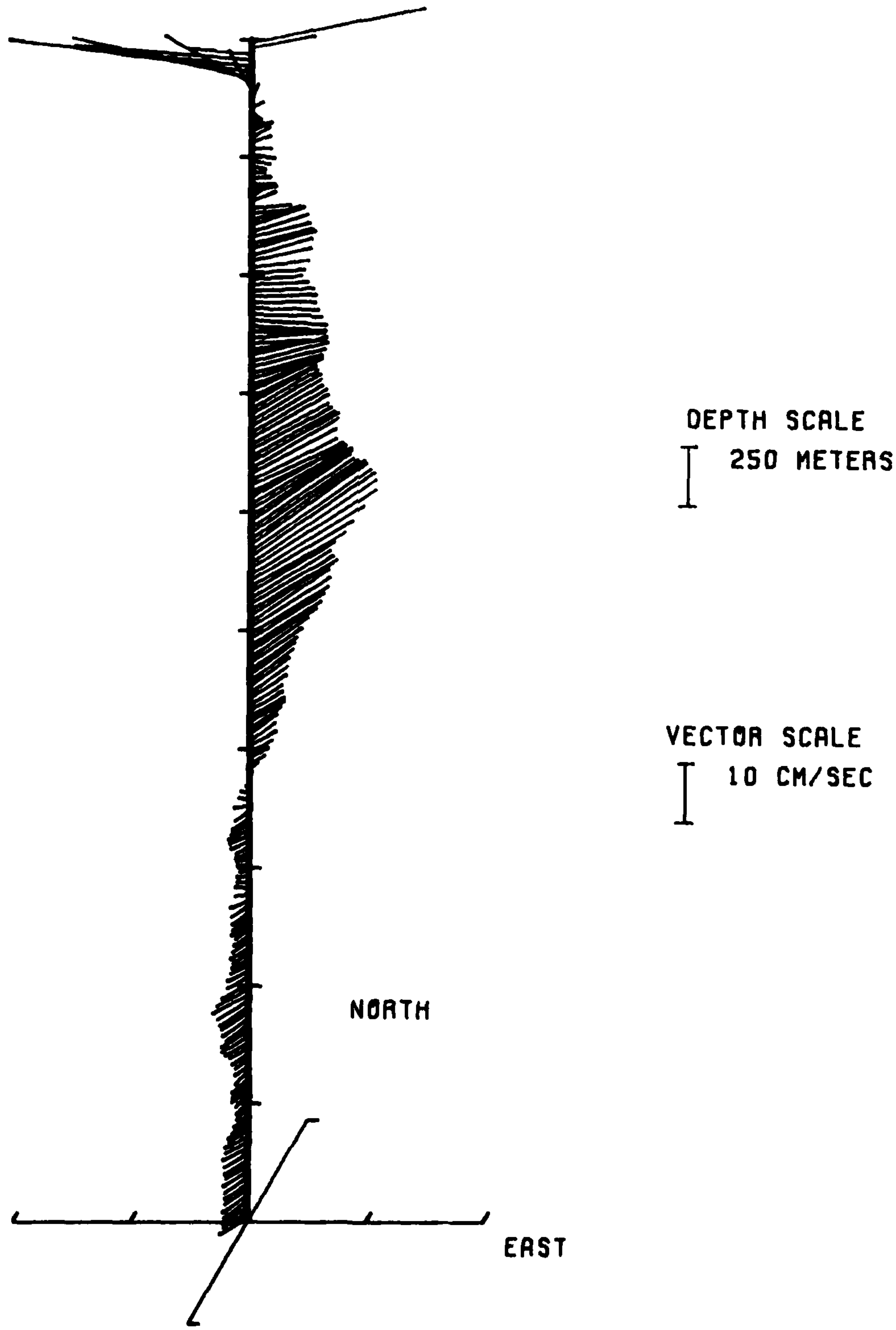


FIGURE 5f

AVERAGE PROFILE, NET 11

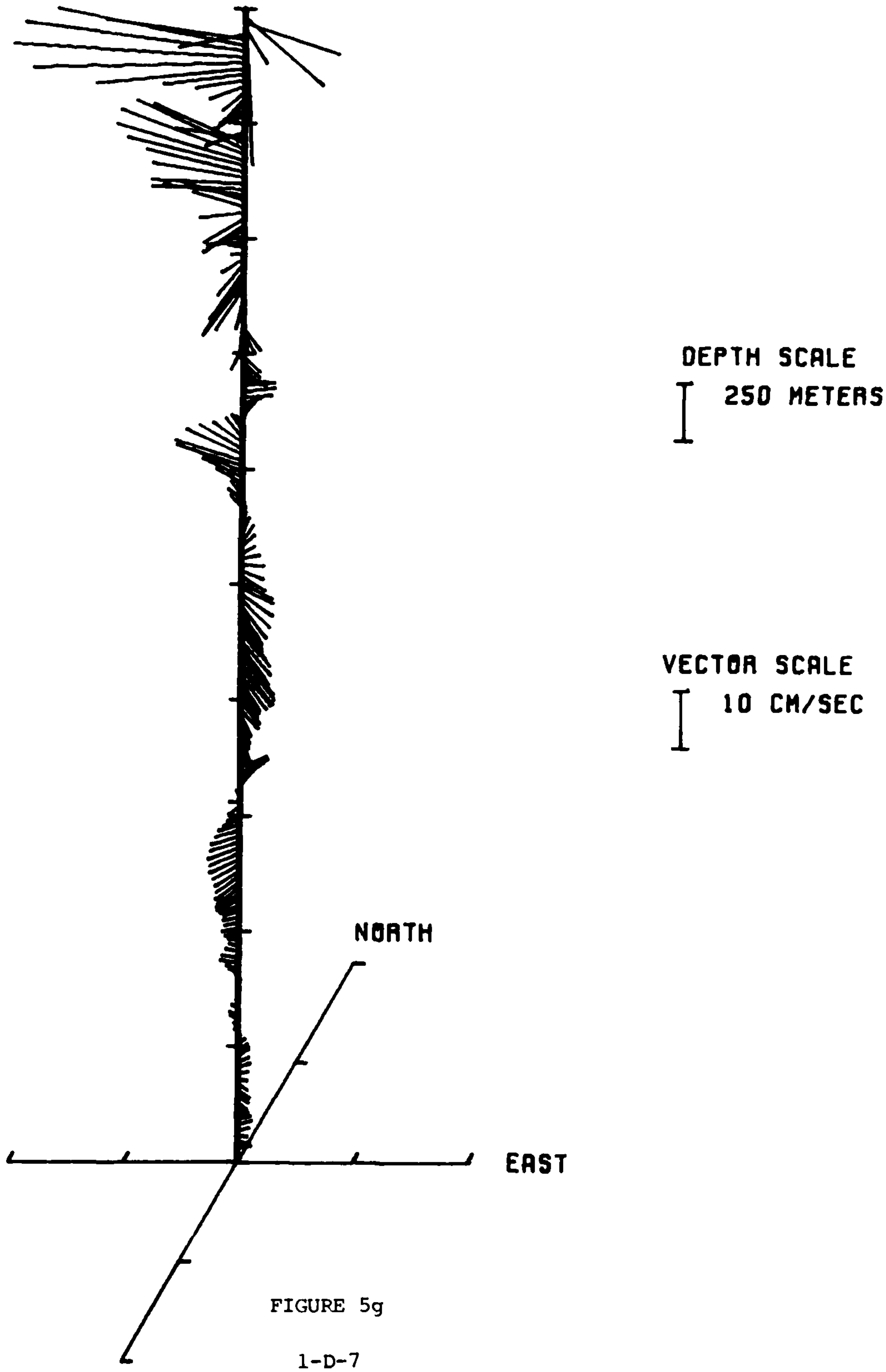


FIGURE 5g

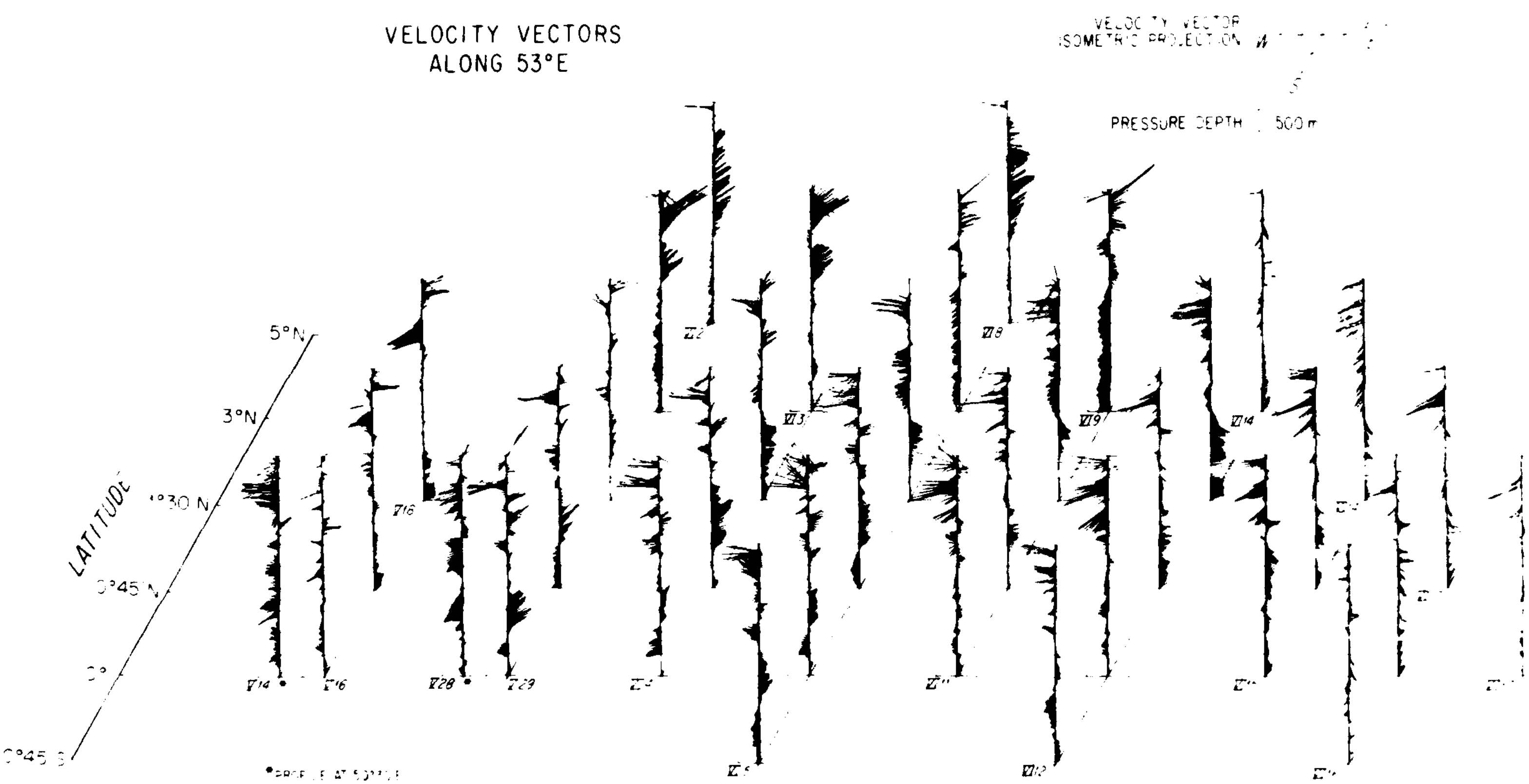


FIGURE 6

Average current vectors shown schematically for each drop

LOCATION OF NET 5

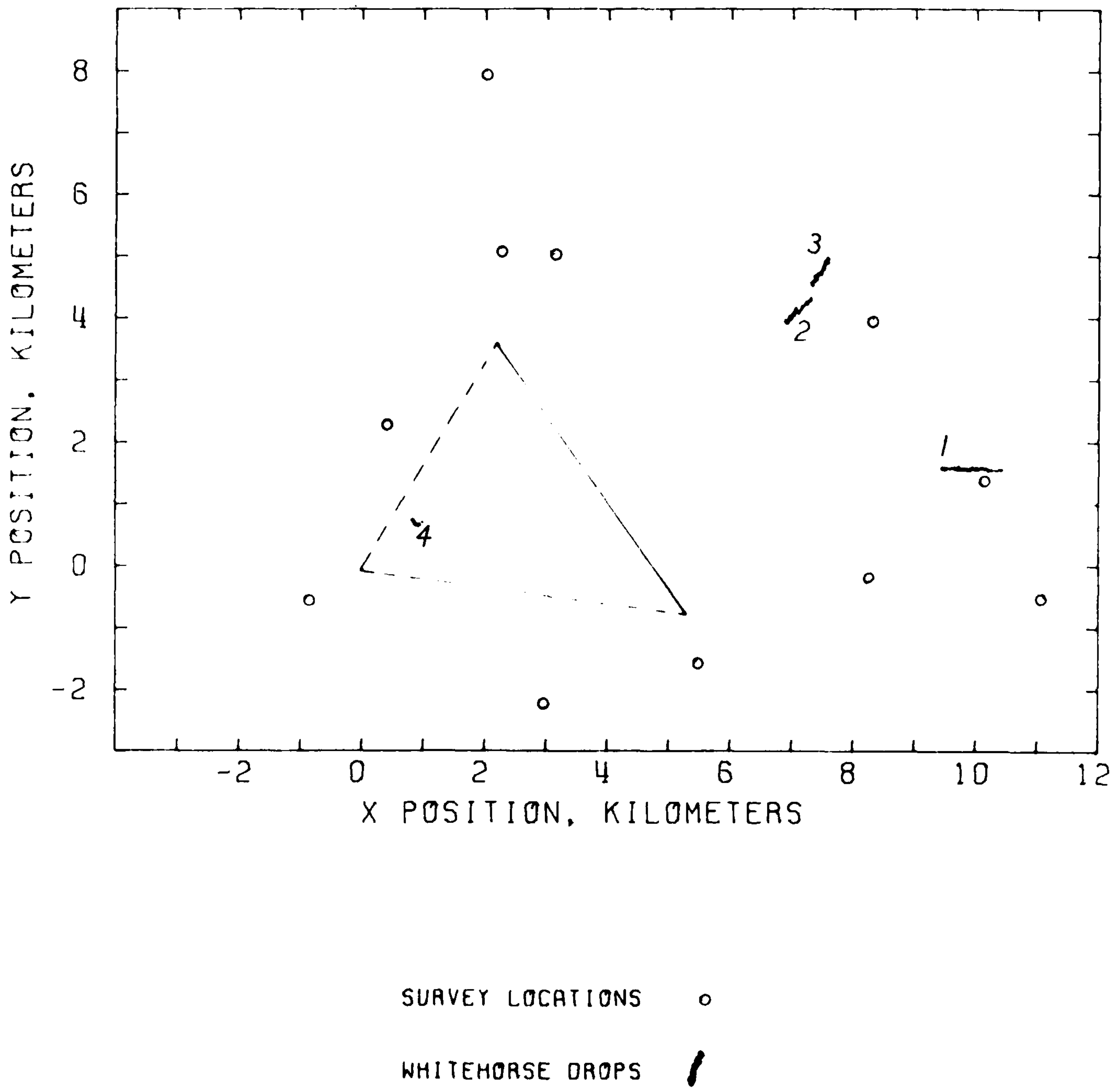


FIGURE 7a

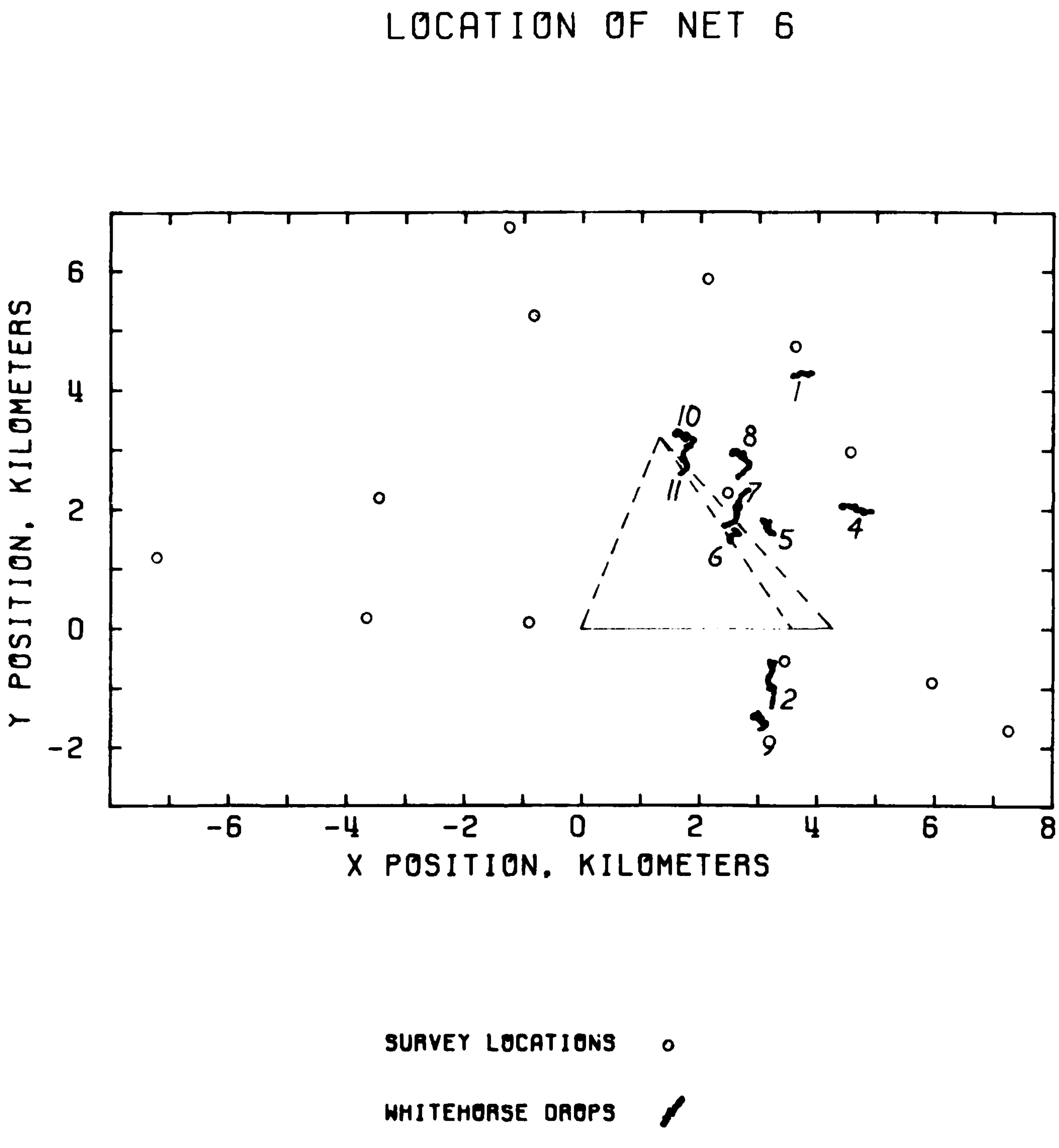

LOCATION OF NET 6
Y POSITION, KILOMETERS
X POSITION, KILOMETERS
6
4
2
0
-2
-6
-4
-2
0
2
4
6
8
1
2
4
5
6
7
8
9
10
11
SURVEY LOCATIONS
WHITEHORSE DROPS

FIGURE 7b

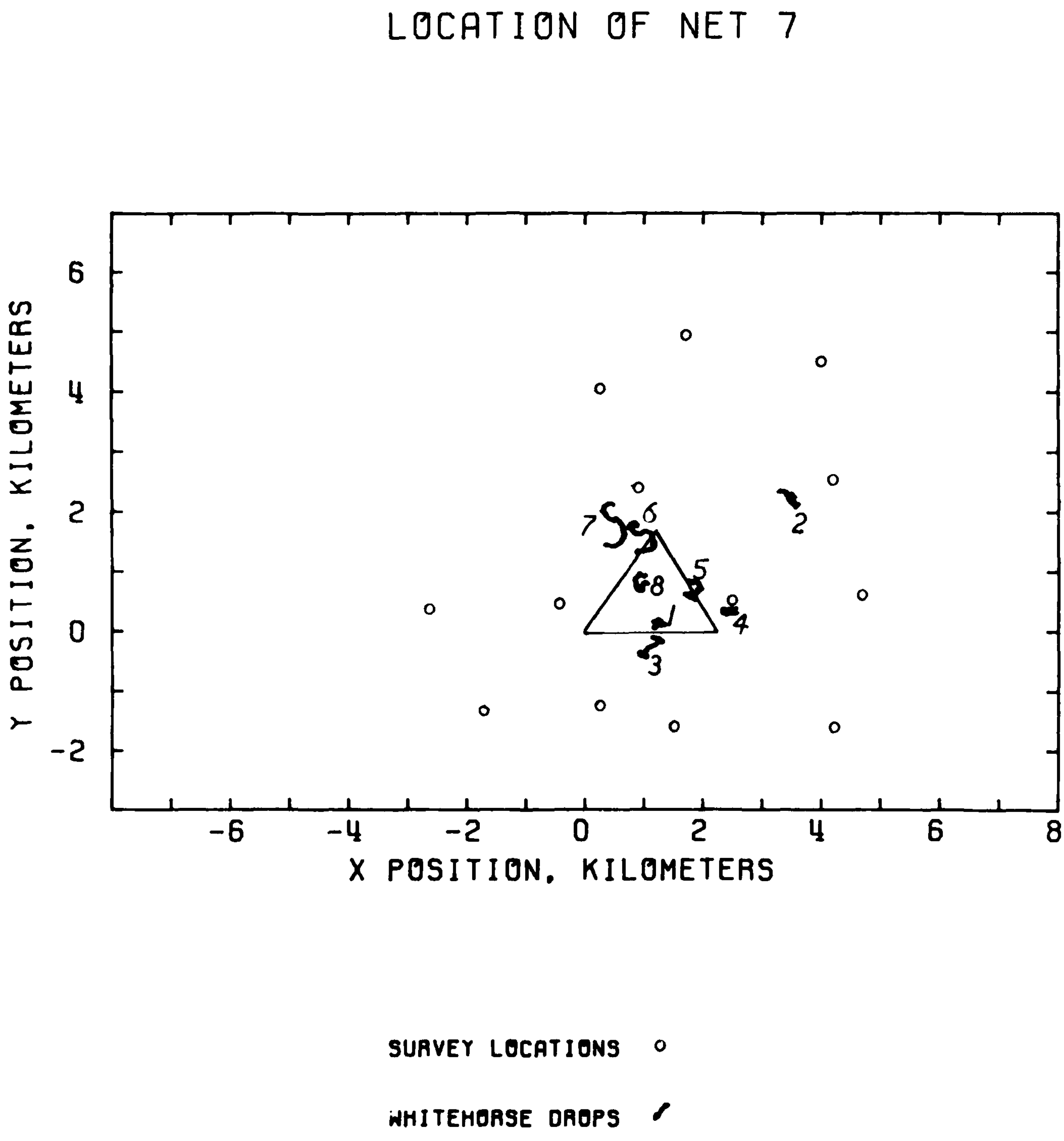
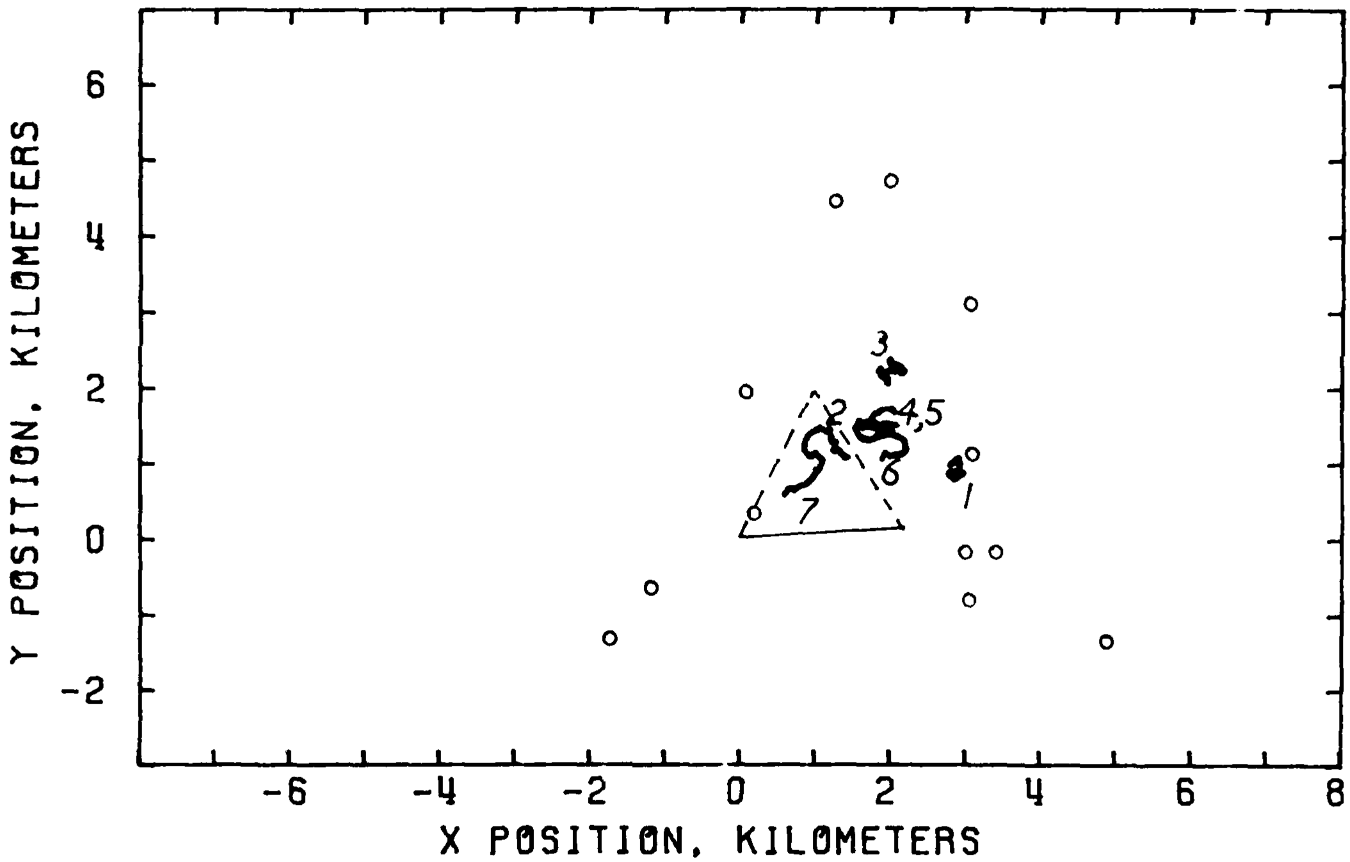

LOCATION OF NET 7
6
4
2
0
-2
Y POSITION, KILOMETERS
-6
-4
-2
0
2
4
6
8
X POSITION, KILOMETERS
7
6
2
5
8
4
3
SURVEY LOCATIONS
WHITEHORSE DROPS

FIGURE 7c

LOCATION OF NET 8



SURVEY LOCATIONS o

WHITEHORSE DROPS

FIGURE 7d

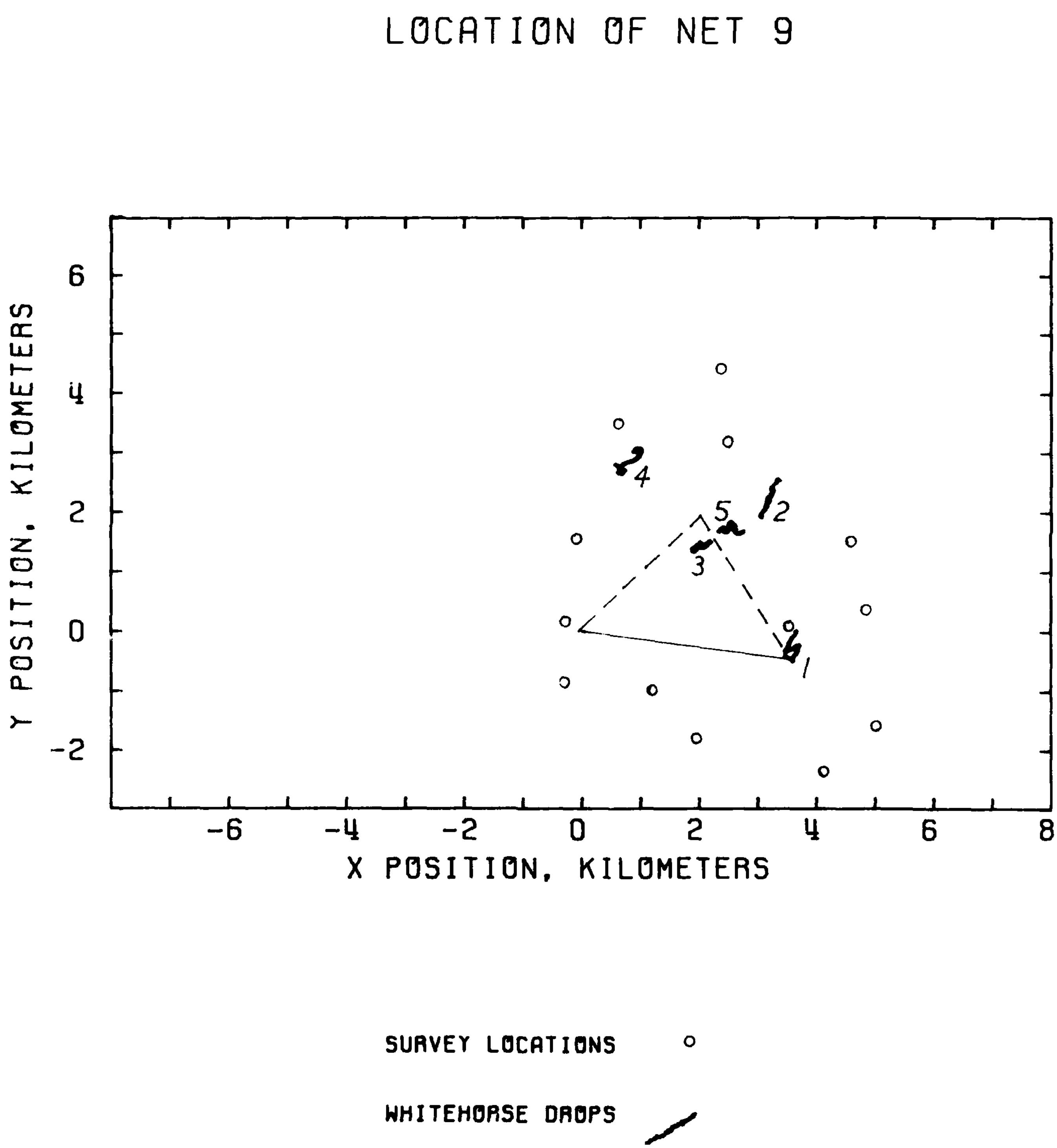

LOCATION OF NET 9
6
4
2
0
-2
Y POSITION, KILOMETERS
-6
-4
-2
0
2
4
6
8
X POSITION, KILOMETERS
1
2
3
4
5
6
SURVEY LOCATIONS
WHITEHORSE DROPS

FIGURE 7e

LOCATION OF NET 10

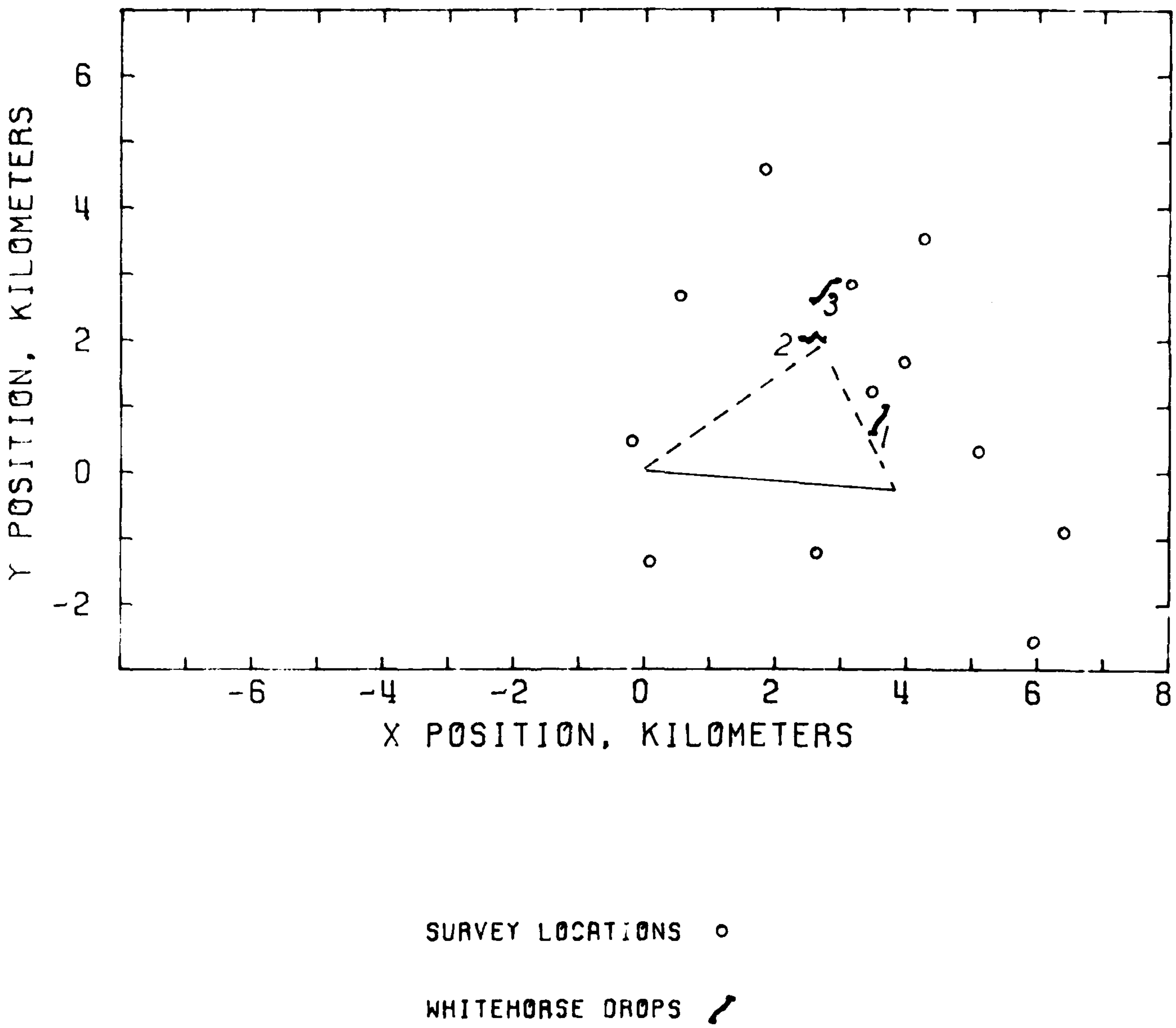


FIGURE 7f

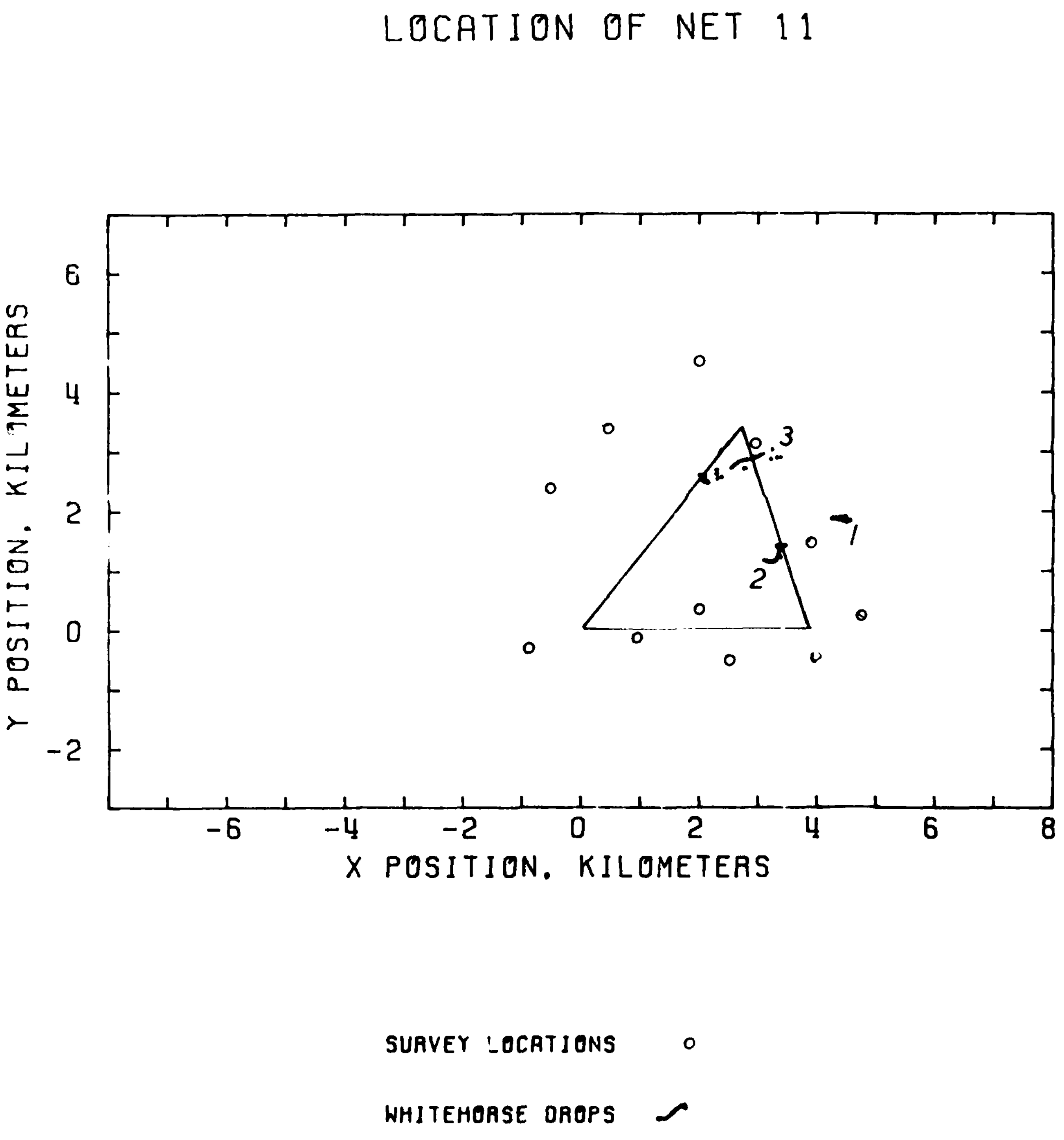

LOCATION OF NET 11
6
4
2
0
-2
Y POSITION, KILOMETERS
-6
-4
-2
0
2
4
6
8
X POSITION, KILOMETERS
3
1
2
SURVEY LOCATIONS
WHITEHORSE DROPS

FIGURE 7a

CURRENT VECTORS MOORING 593

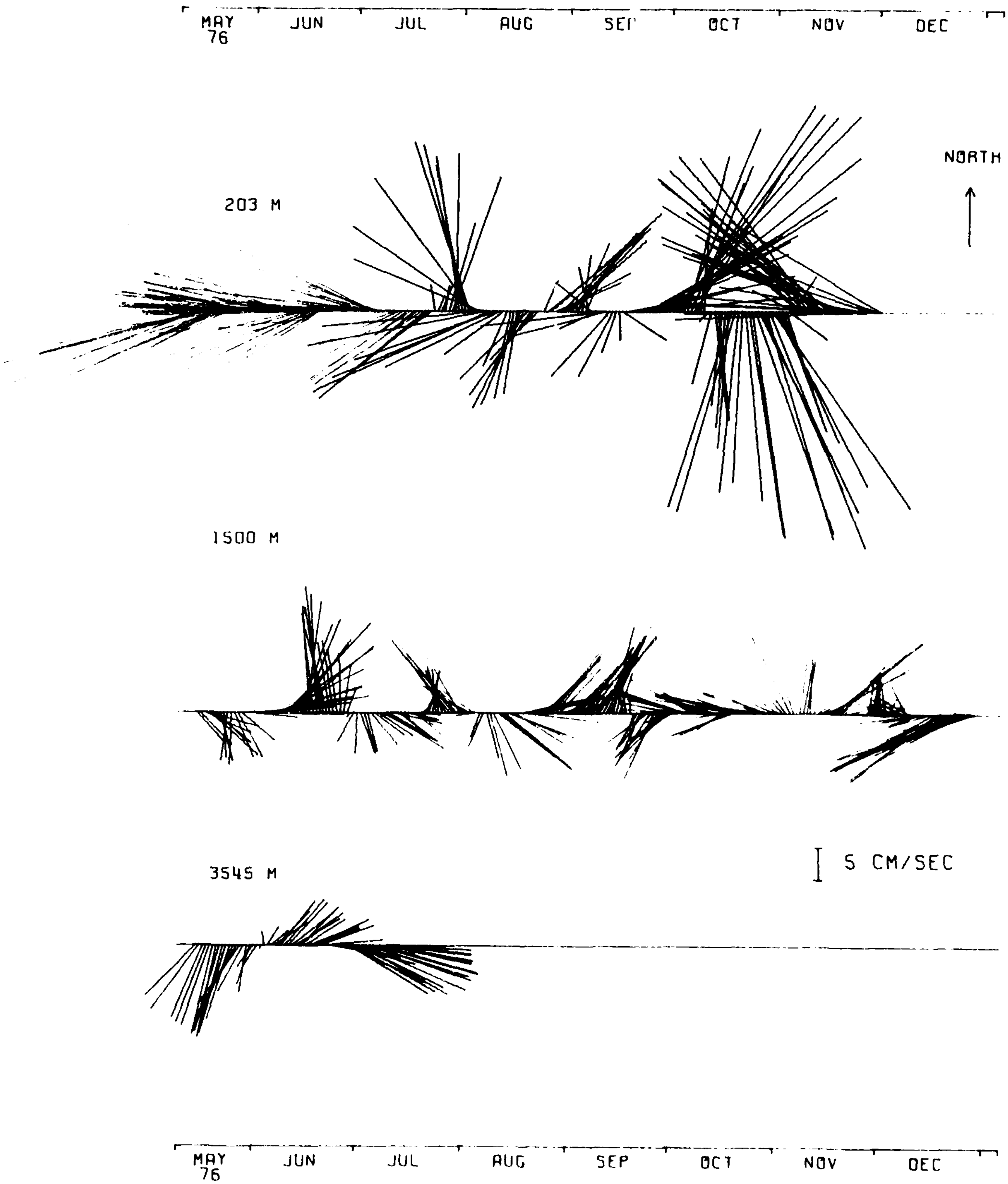


FIGURE 8a

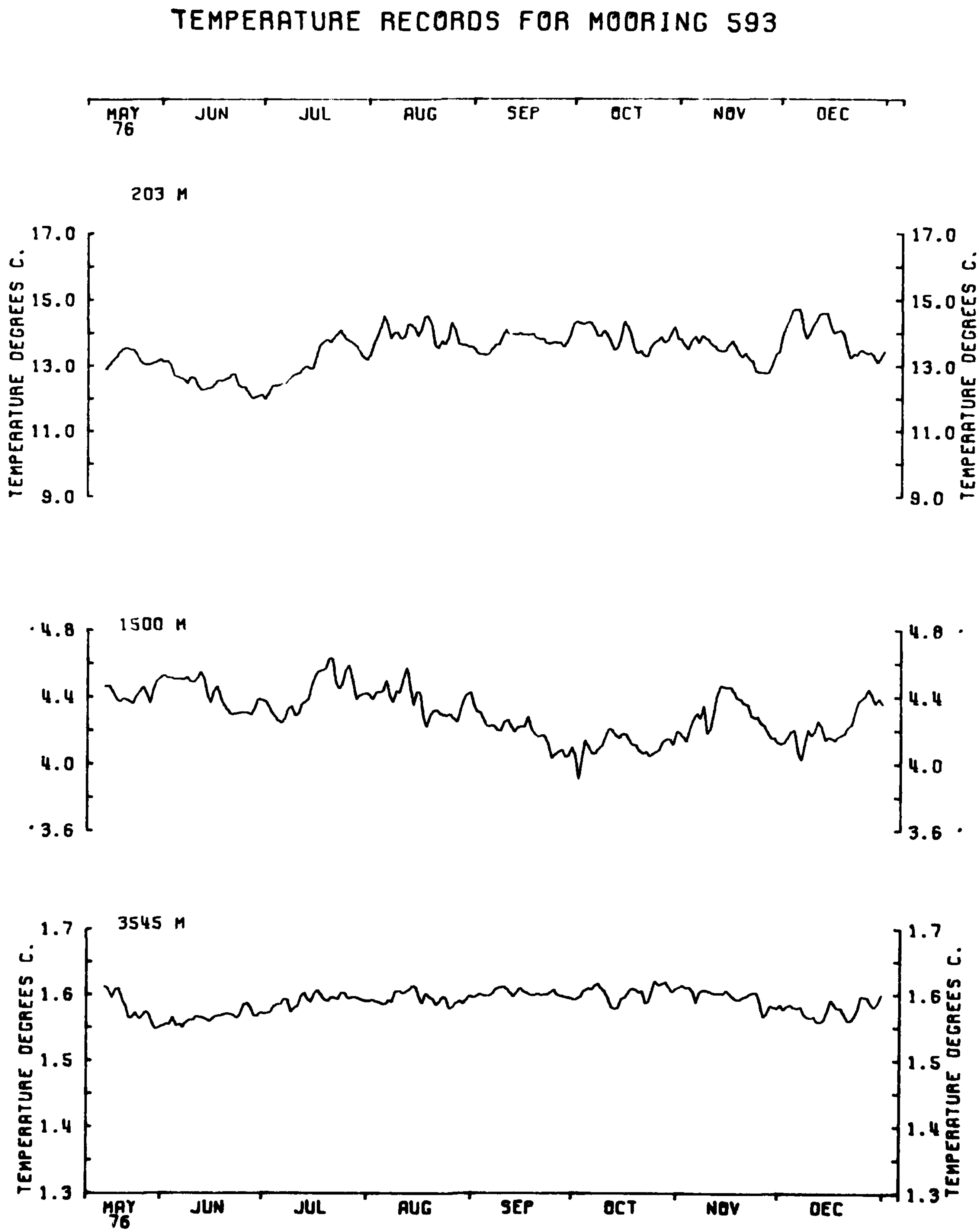

TEMPERATURE RECORDS FOR MOORING 593
MAY 76
JUN
JUL
AUG
SEP
OCT
NOV
DEC
203 M
1500 M
3545 M
TEMPERATURE DEGREES C.
17.0
15.0
13.0
11.0
9.0
4.8
4.4
4.0
3.6
1.7
1.6
1.5
1.4
1.3

FIGURE 9a

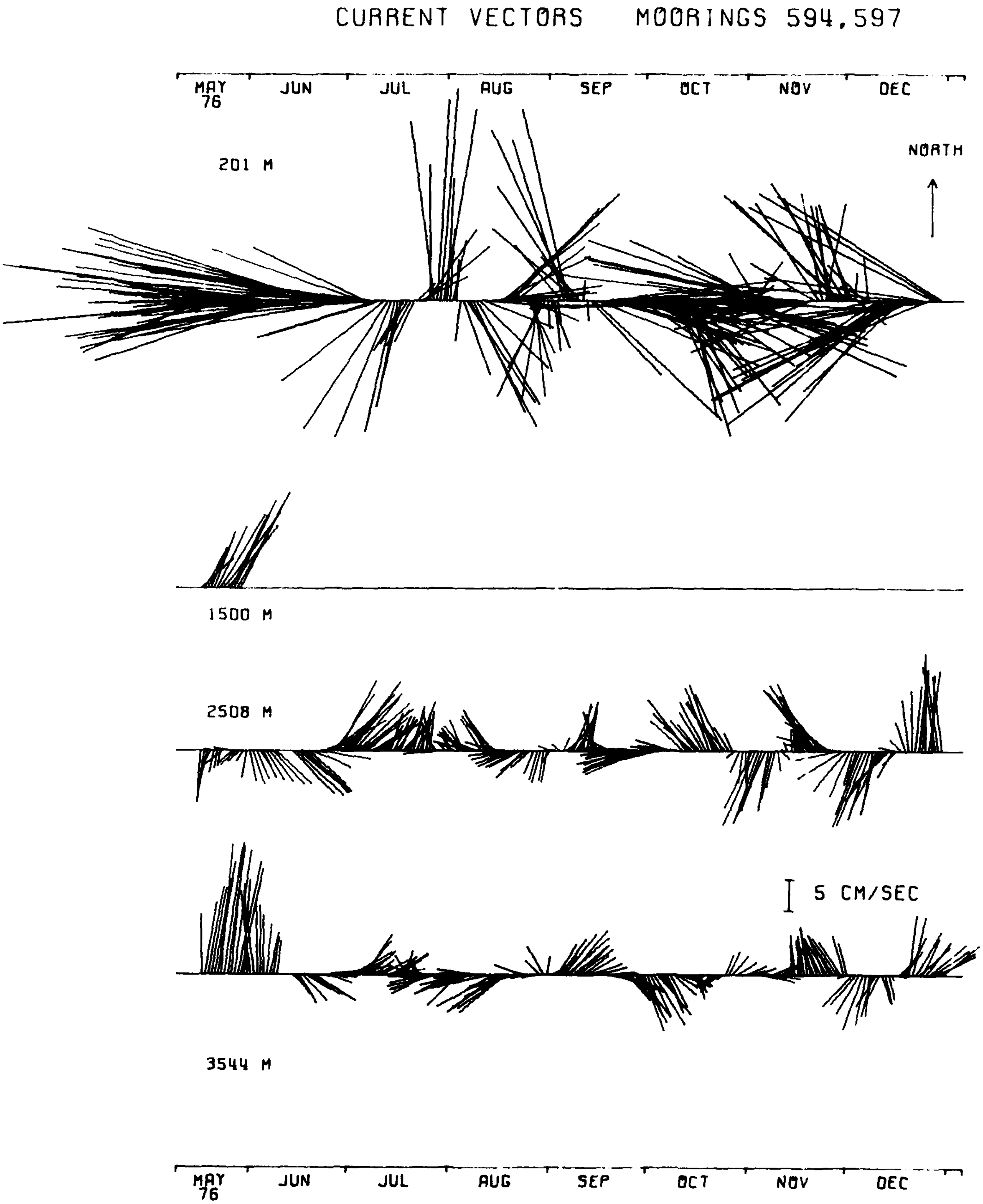

CURRENT VECTORS MOORINGS 594,597
MAY 76
JUN
JUL
AUG
SEP
OCT
NOV
DEC
201 M
NORTH
1500 M
2508 M
5 CM/SEC
3544 M
MAY 76
JUN
JUL
AUG
SEP
OCT
NOV
DEC

FIGURE 8b

TEMPERATURE RECORDS FOR MOORINGS 594,597

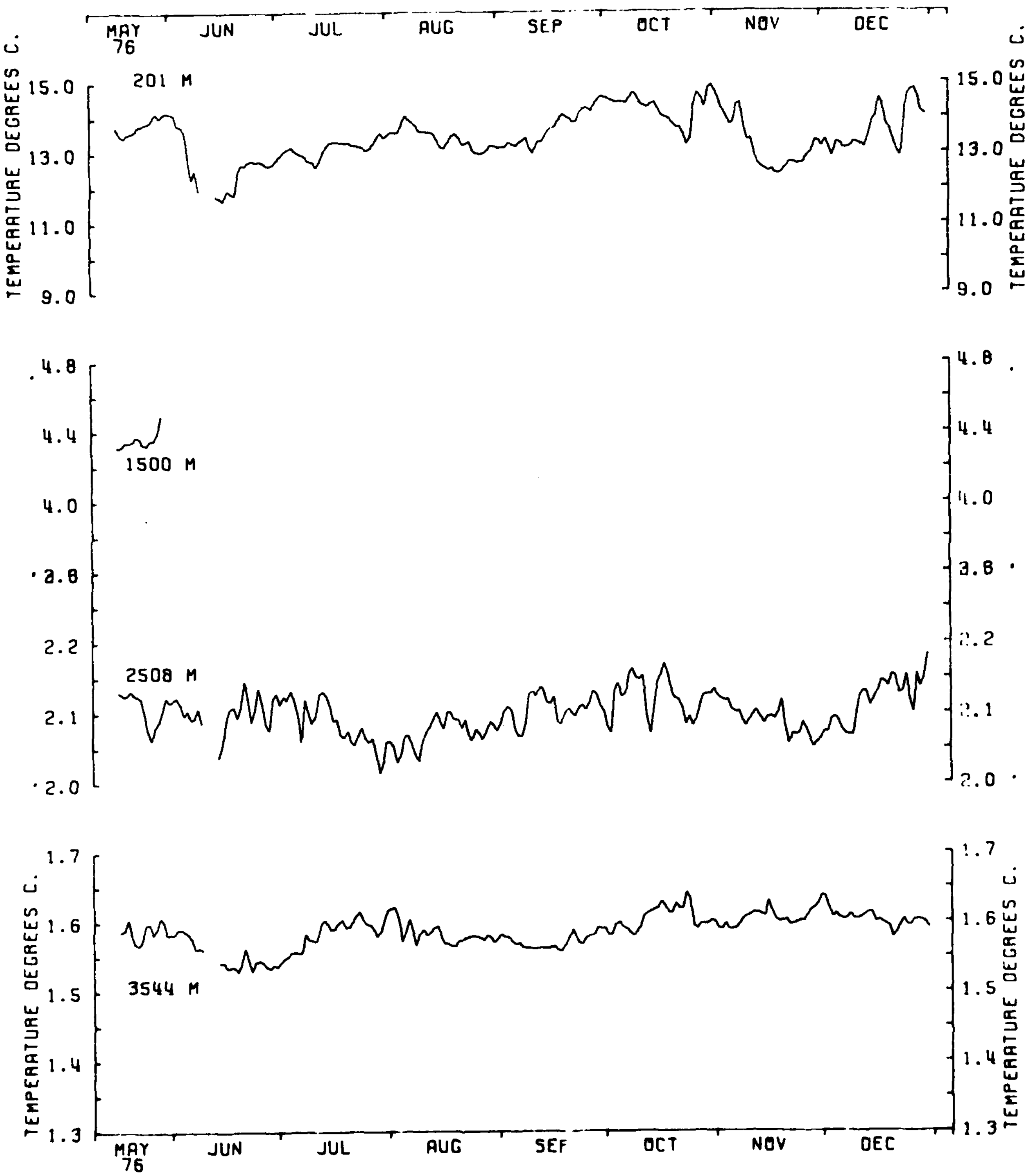


FIGURE 9b

CURRENT VECTORS MOORING 595

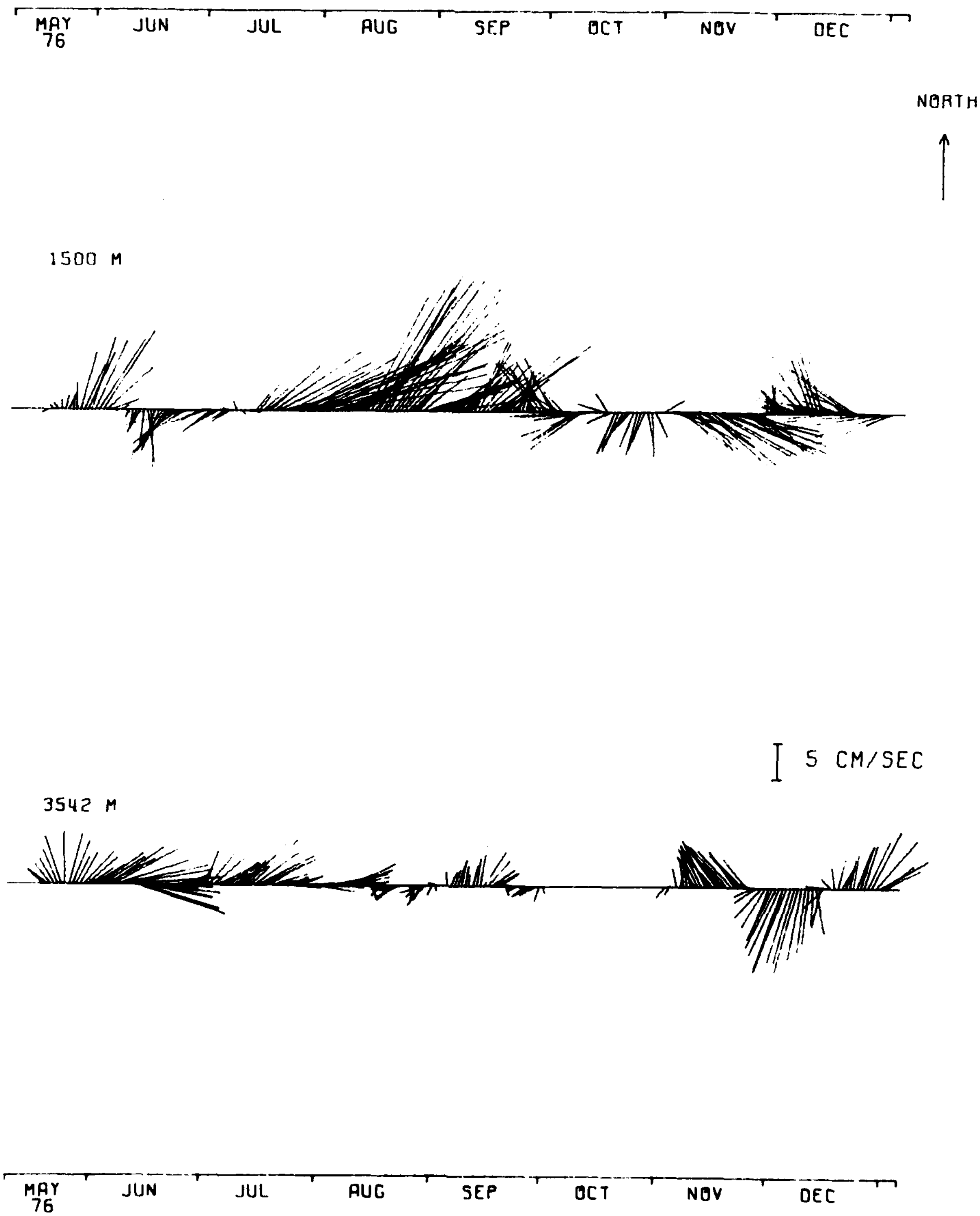


FIGURE 8c

TEMPERATURE RECORDS FOR MOORING 595

39

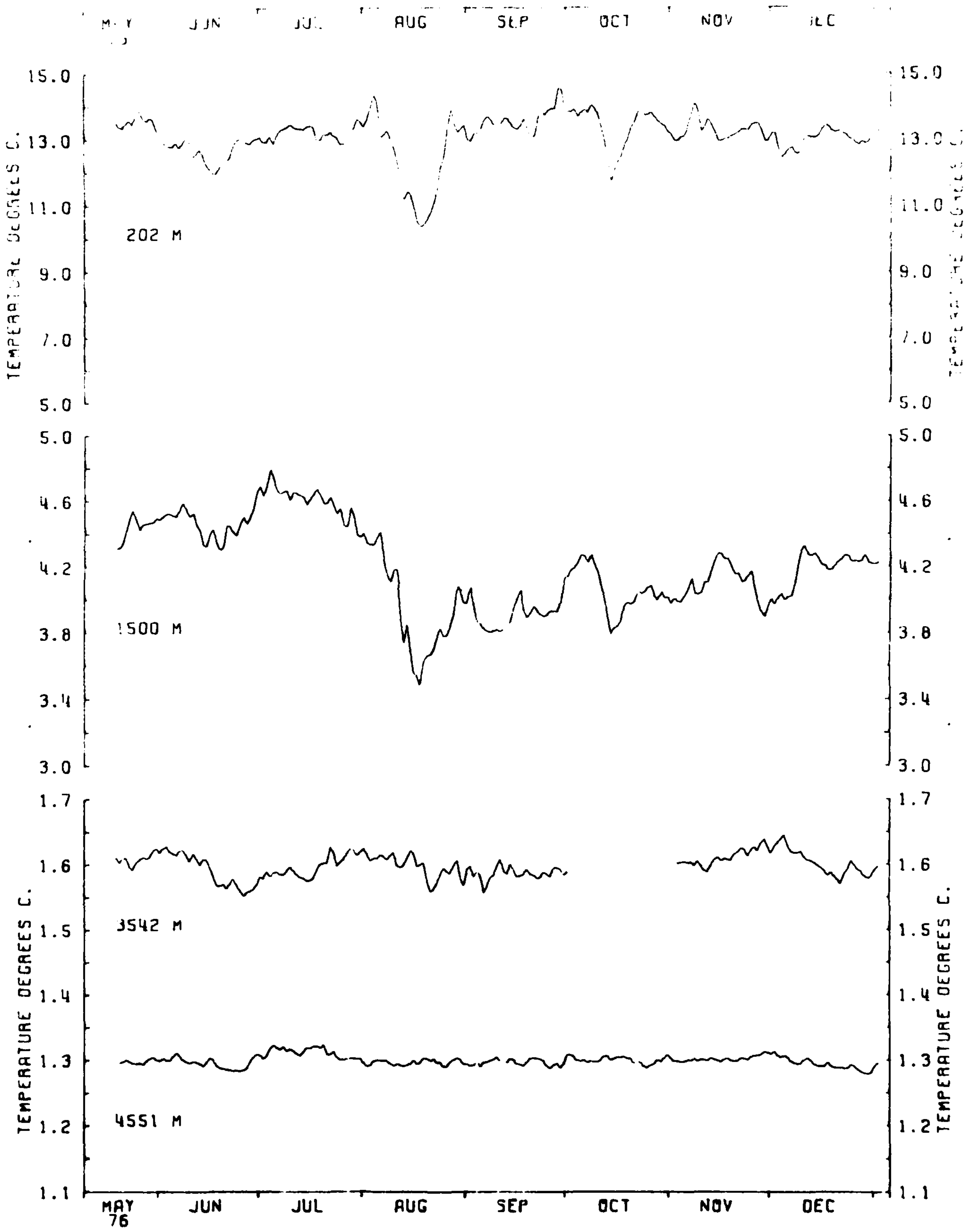


FIGURE 9c

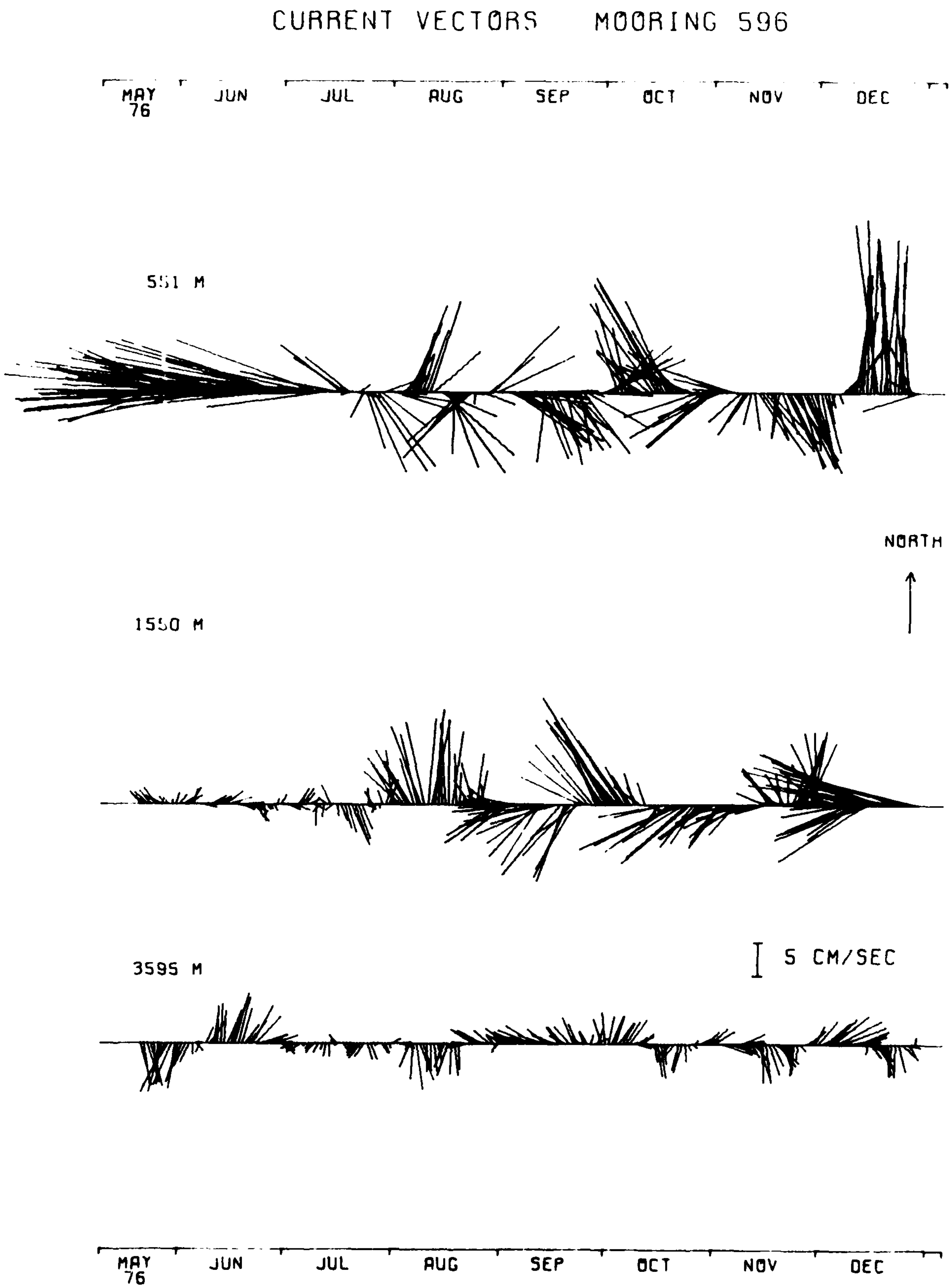

CURRENT VECTORS MOORING 596
MAY 76
JUN
JUL
AUG
SEP
OCT
NOV
DEC
551 M
NORTH
1550 M
5 CM/SEC
3595 M
MAY 76
JUN
JUL
AUG
SEP
OCT
NOV
DEC

FIGURE 8d

TEMPERATURE RECORDS FOR MOORING 596

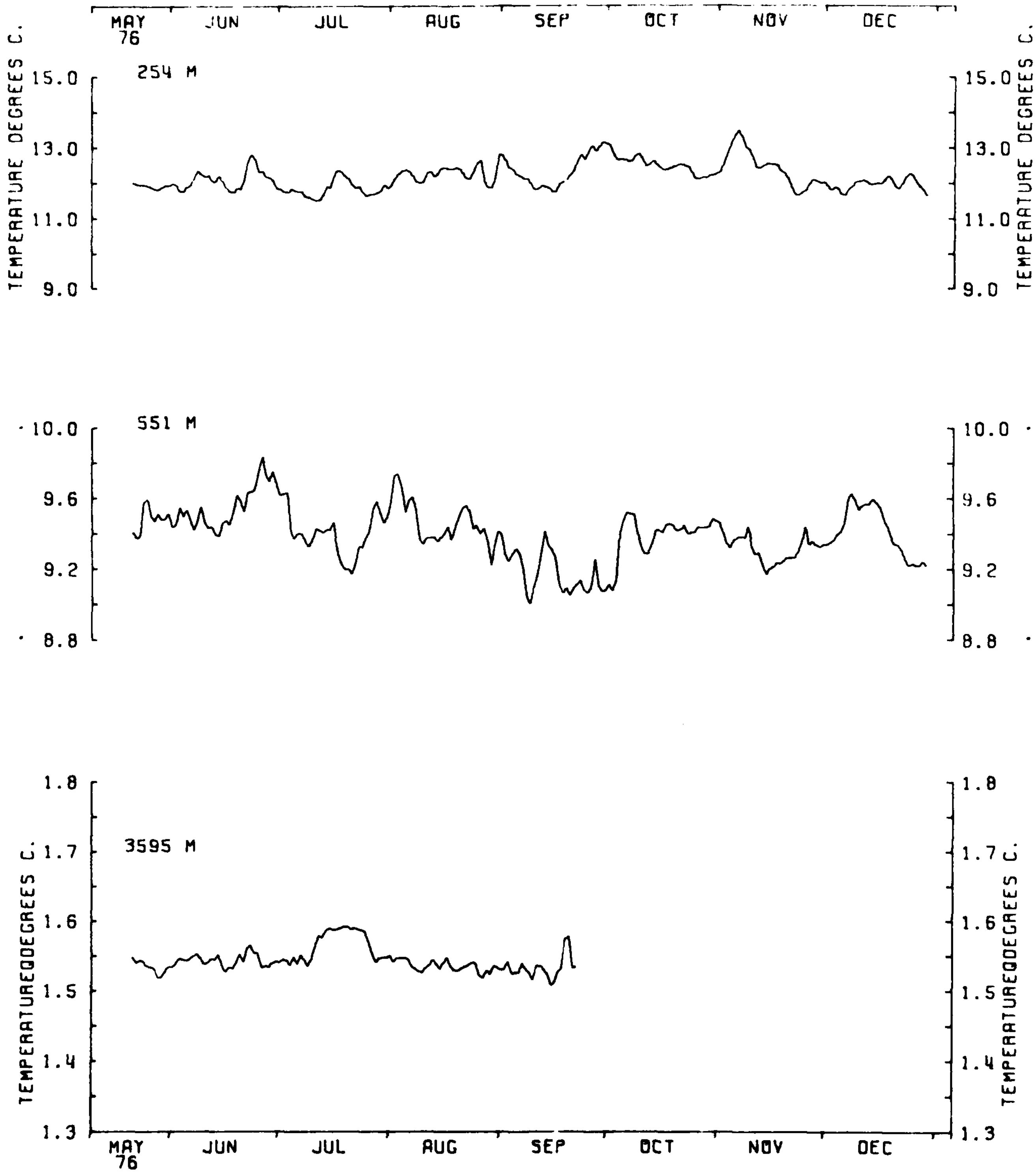


FIGURE 9d

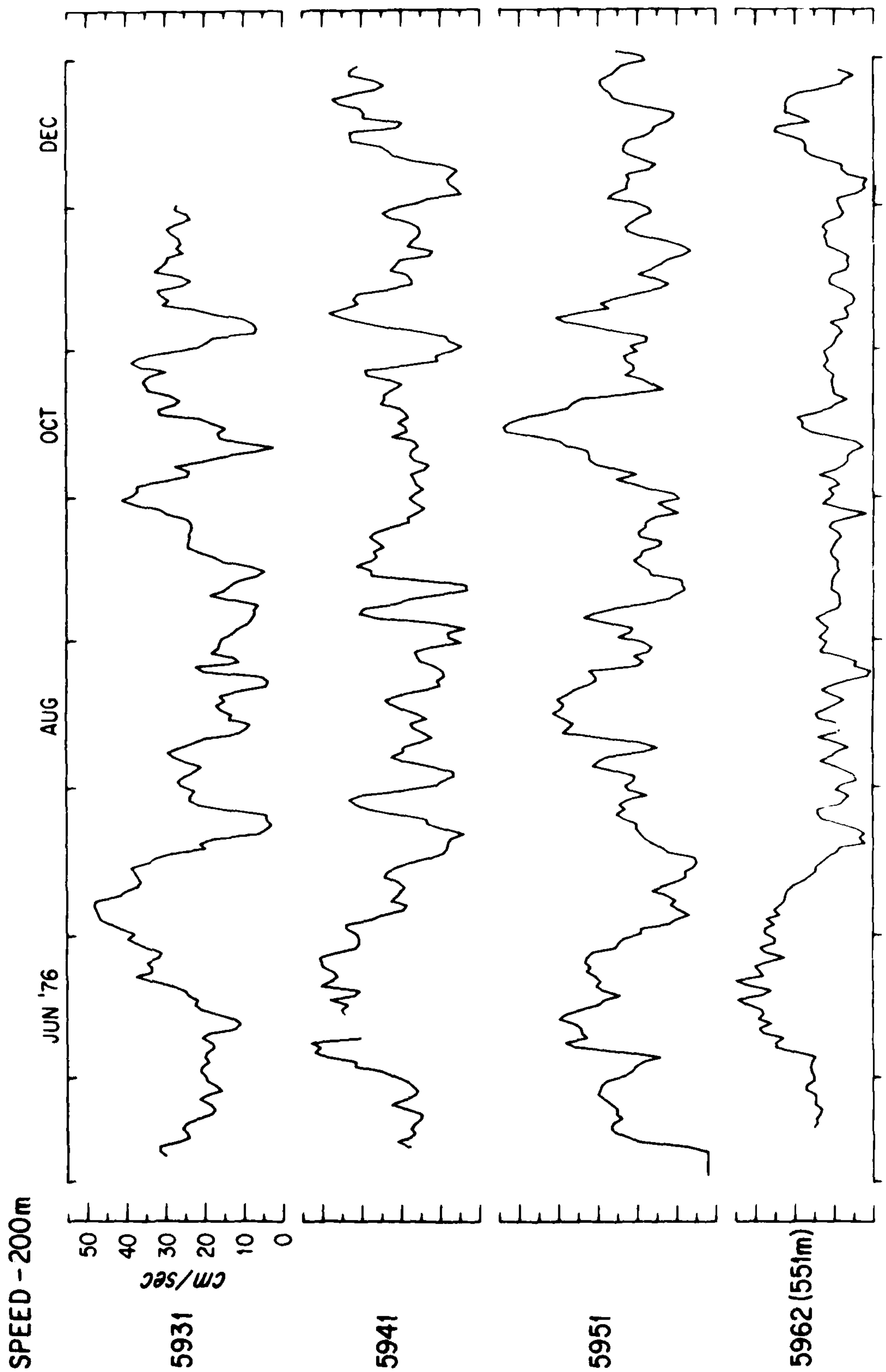

SPEED - 200m
cm/sec
50
40
30
20
10
0
5931
5941
5951
5962 (551m)
JUN '76
AUG
OCT
DEC

FIGURE 15a

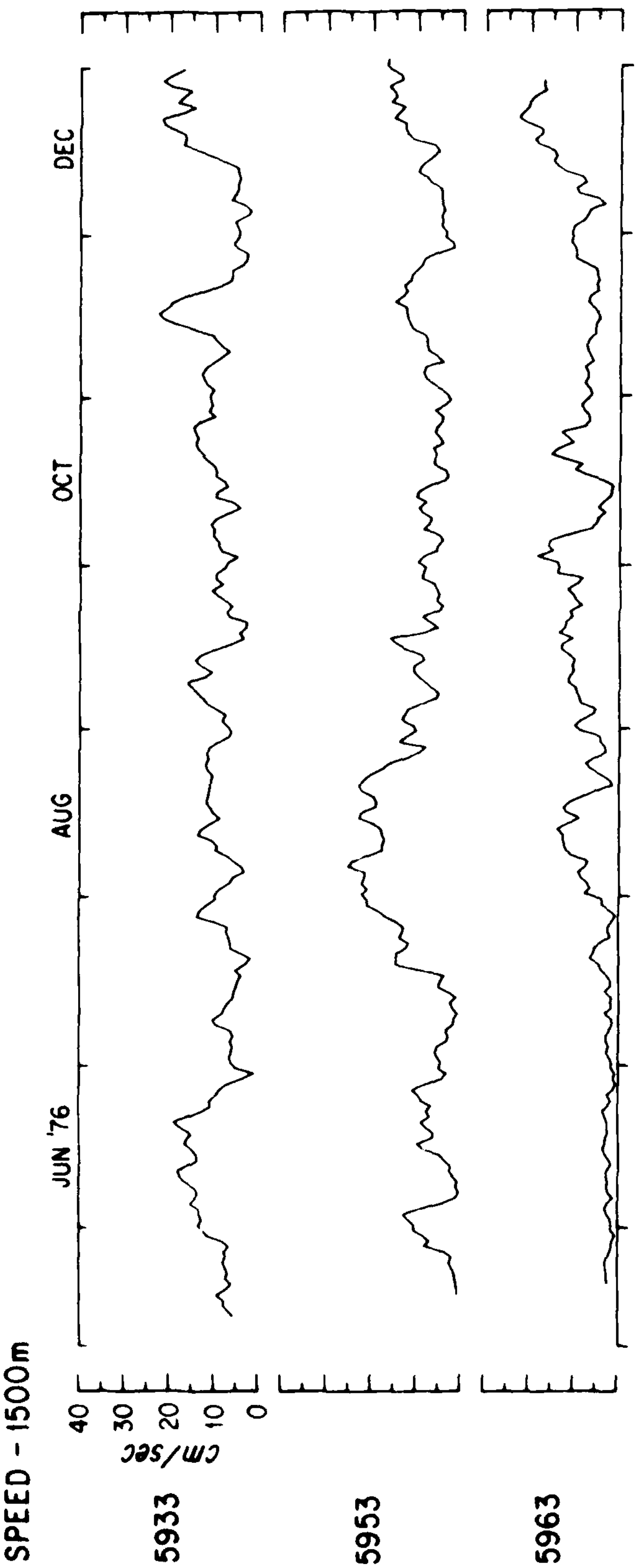

SPEED - 1500m
5933
5953
5963
cm/sec
40
30
20
10
0
JUN '76
AUG
OCT
DEC

FIGURE 10b

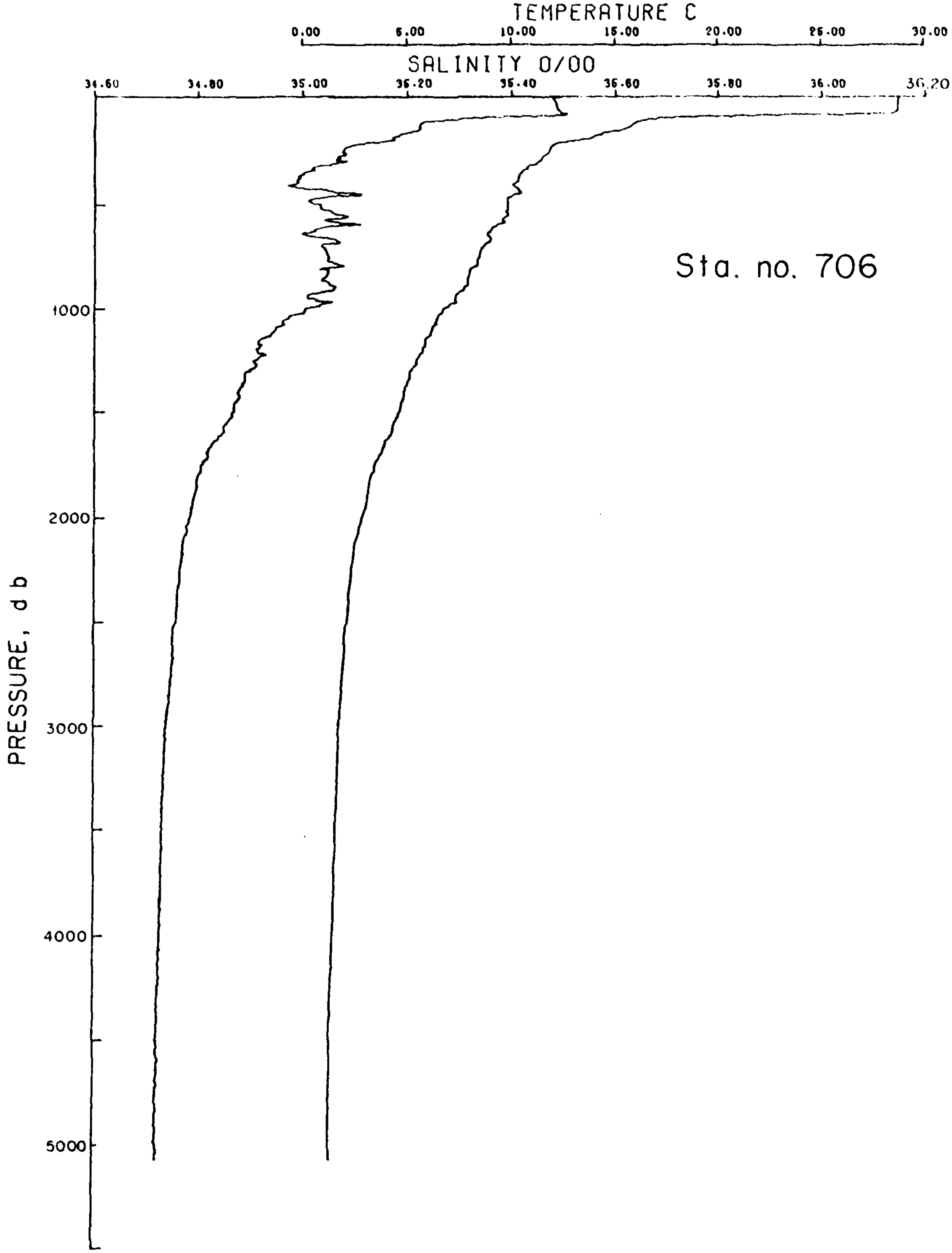


Figure 11a
CTD Profile

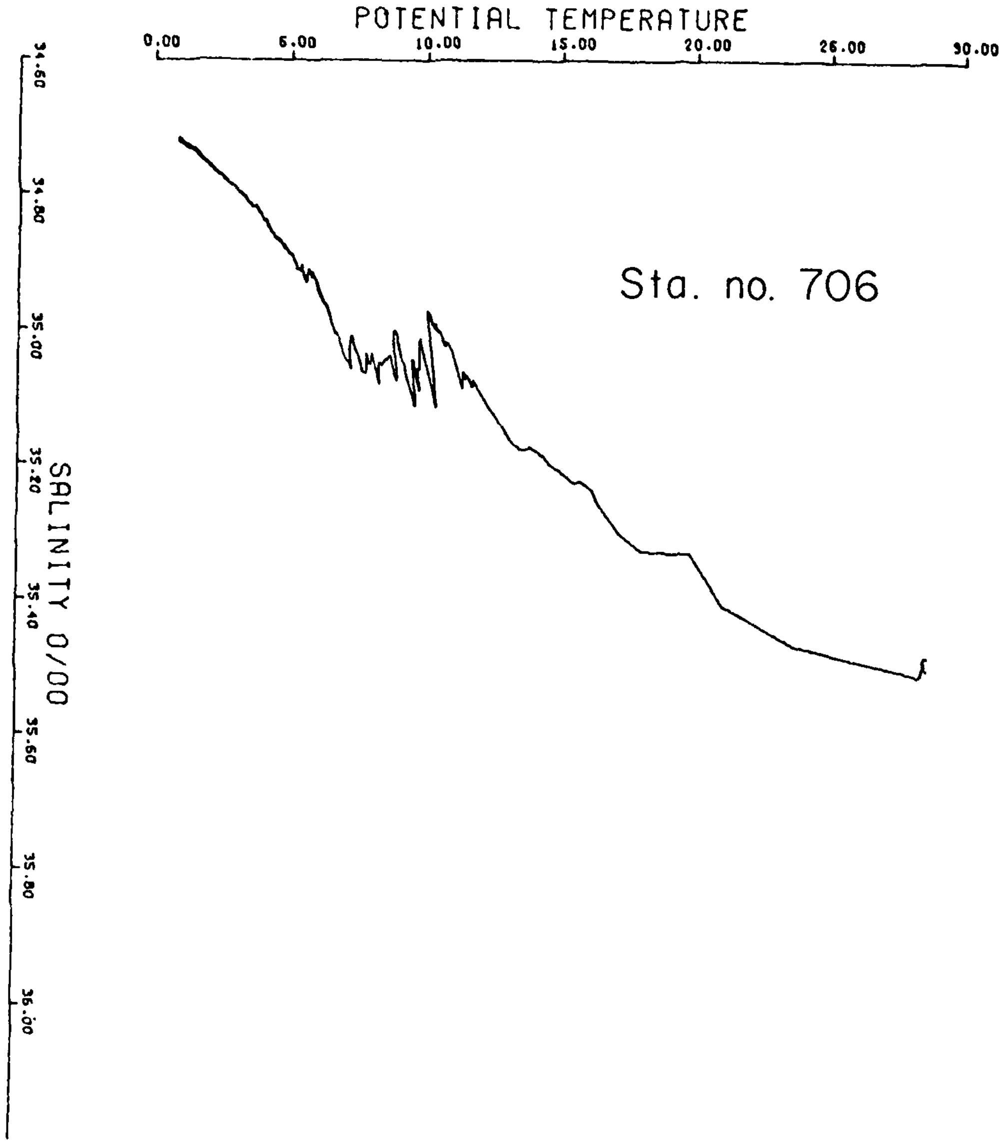


Figure 11b
T-S Diagram

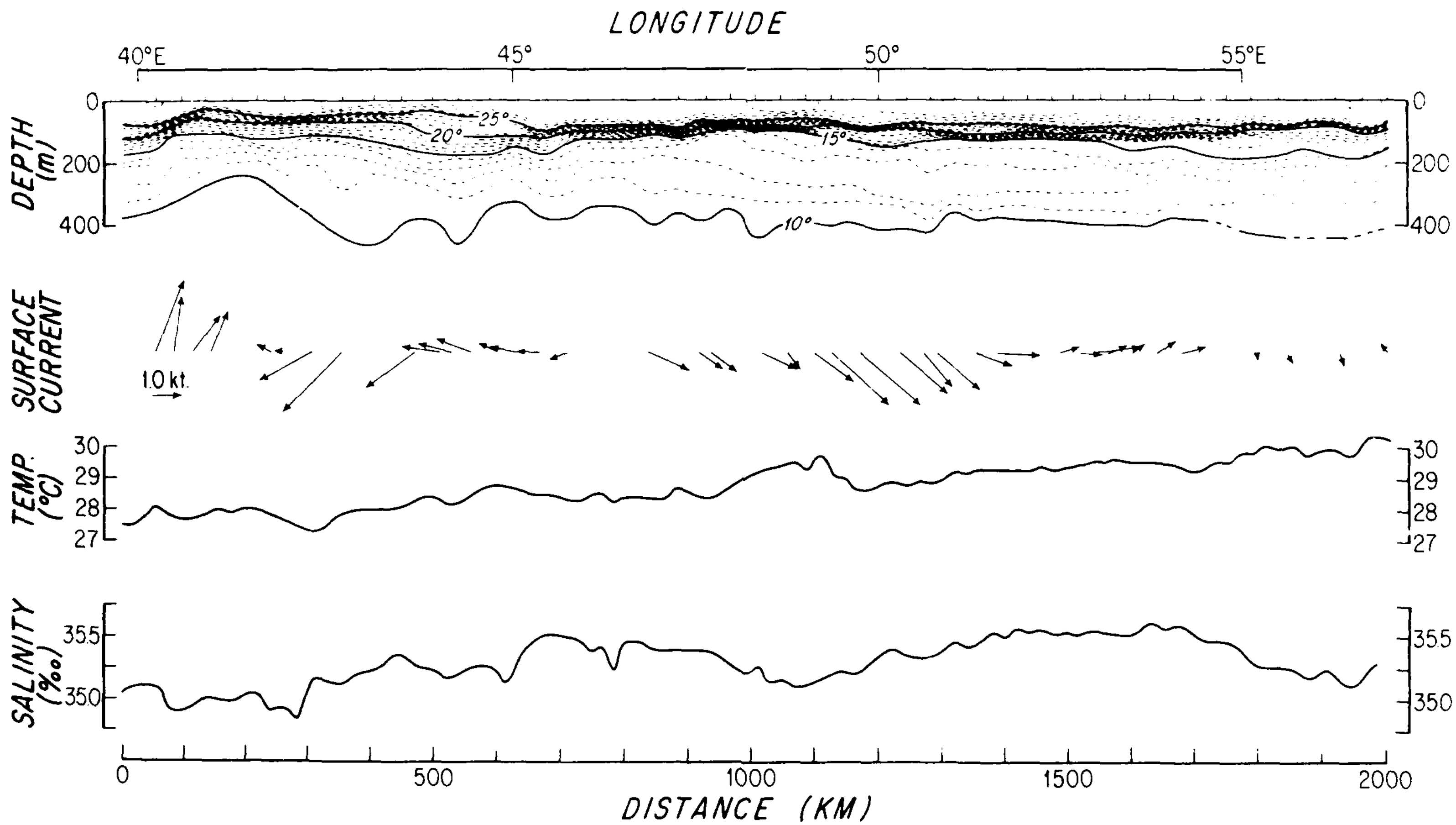


FIGURE 12b

XBT Section and Surface Data
Site of Mooring 596 to Mombasa, May 19-22 1976)

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A COMPILATION OF MOORED CURRENT METER DATA, WHITE HORSE PROFILES AND ASSOCIATED OCEANOGRAPHIC OBSERVATIONS, VOLUME XXIV (INDIAN OCEAN ARRAY, 1976) by Ann Spencer, Kathleen O'Neill and James R. Luyten. 46 pages. October 1980. Prepared for the Office of Naval Research under Contract N00014-76-C-0197; NR 083-400 and for the National Science Foundation under Grants ATM76-02196, ATM78-21491 and DES72-01384.

Current and temperature measurements are presented from instruments deployed during May of 1976 in the western Indian Ocean, between 50°E and 57°E and between 1°S and 5°N. The experiment was part of the INDEX program.

Seven mooring sites were occupied. Fourteen current meters and five temperature/pressure recorders were on WHOI moorings at 4 of the sites. Two current meters and eleven temperature/pressure recorders were on MIT moorings at 3 sites. Most of resulting data records are of eight months duration. A current profiler, the White Horse, was also used, and 41 profiles were taken over a six-week period.

Basic data from the current meters are presented in statistical tables and graphically as scatter plots, progressive vector plots, spectral plots and time series plots. Filtered time series are shown in composite displays.

Basic White Horse data are presented as east and north current component profiles, position plots and perspective vector plots.

Selected CTD data are displayed as plots of potential temperature and salinity versus pressure, and as T-S daigrams. Data from four XBT sections are displayed graphically.

1. Ocean currents
2. Ocean temperatures
3. Indian Ocean

I. Spencer, Ann
II. O'Neill, Kathleen
III. Luyten, James R.
IV. N00014-76-C-0197; NR 083-400
V. ATM76-02196
VI. ATM78-21491
VII. DES72-01384

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1. Ocean currents
2. Ocean temperatures
3. Indian Ocean

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II. O'Neill, Kathleen
III. Luyten, James R.
IV. N00014-76-C-0197; NR 083-400
V. ATM76-02196
VI. ATM78-21491
VII. DES72-01384

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WHOI-80-41

A COMPILATION OF MOORED CURRENT METER DATA, WHITE HORSE PROFILES AND ASSOCIATED OCEANOGRAPHIC OBSERVATIONS, VOLUME XXIV (INDIAN OCEAN ARRAY, 1976) by Ann Spencer, Kathleen O'Neill and James R. Luyten. 46 pages. October 1980. Prepared for the Office of Naval Research under Contract N00014-76-C-0197; NR 083-400 and for the National Science Foundation under Grants ATM76-02196, ATM78-21491 and DES72-01384.

Current and temperature measurements are presented from instruments deployed during May of 1976 in the western Indian Ocean, between 50°E and 57°E and between 1°S and 5°N. The experiment was part of the INDEX program.

Seven mooring sites were occupied. Fourteen current meters and five temperature/pressure recorders were on WHOI moorings at 4 of the sites. Two current meters and eleven temperature/pressure recorders were on MIT moorings at 3 sites. Most of resulting data records are of eight months duration. A current profiler, the White Horse, was also used, and 41 profiles were taken over a six-week period.

Basic data from the current meters are presented in statistical tables and graphically as scatter plots, progressive vector plots, spectral plots and time series plots. Filtered time series are shown in composite displays.

Basic White Horse data are presented as east and north current component profiles, position plots and perspective vector plots.

Selected CTD data are displayed as plots of potential temperature and salinity versus pressure, and as T-S daigrams. Data from four XBT sections are displayed graphically.

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